# PETROLEUM PROCESSING

*including Petrochemical Processing Section*

NOVEMBER 1953

## Picking Motor Controls

How to select the best one for your own individual plant—p. 1692

## Sulfur Plant Problems

Why do tubes fail in your recovery unit boiler—and what to do about them —p. 1713

## Automatic Drum Filler

One-man machine fills 1000 55-gal. drums/day, pays for itself in 20 months —p. 1729

## What Does Corrosion Cost You?

**A STAFF REPORT**
*by the Editors of*
*Petroleum Processing*

THE cost to refiners of having to contend with corrosion of metals in their plants averages 9 cents a barrel of crude oil processed, PETROLEUM PROCESSING estimates following a country-wide survey by its Editorial Staff.

On the volume of crude oil run to stills in 1952, the total estimated direct cost required through handling corrosive substances of many kinds was $219,700,000. This cost is an important factor today in plant operations and even larger in plant maintenance. Because of the complexity of the problem, cost of corrosion in natural gasoline plants and in petrochemical units was not included in PETROLEUM PROCESSING'S study.

Using this average cost figure for straight petroleum refining, the possible direct cost of corrosion to some of the larger oil companies runs into millions annually, and in some cases amounts to 15% or more of their reported net incomes. For a 10,000-barrel refinery, the cost of corrosion, unchecked, could run into the hundred thousands annually. An accompanying table shows the possible, not actual, cost of corrosion to 35 oil companies, based on the estimated general average of 9 cents a barrel of crude processed.

Up to 20% of this direct cost to refiners contending with corrosion—$45,000,000 a year—can be saved by the oil companies, various authorities believe, through the application of methods for corrosion protection now proved to be . . .

—continued on pg. 1686

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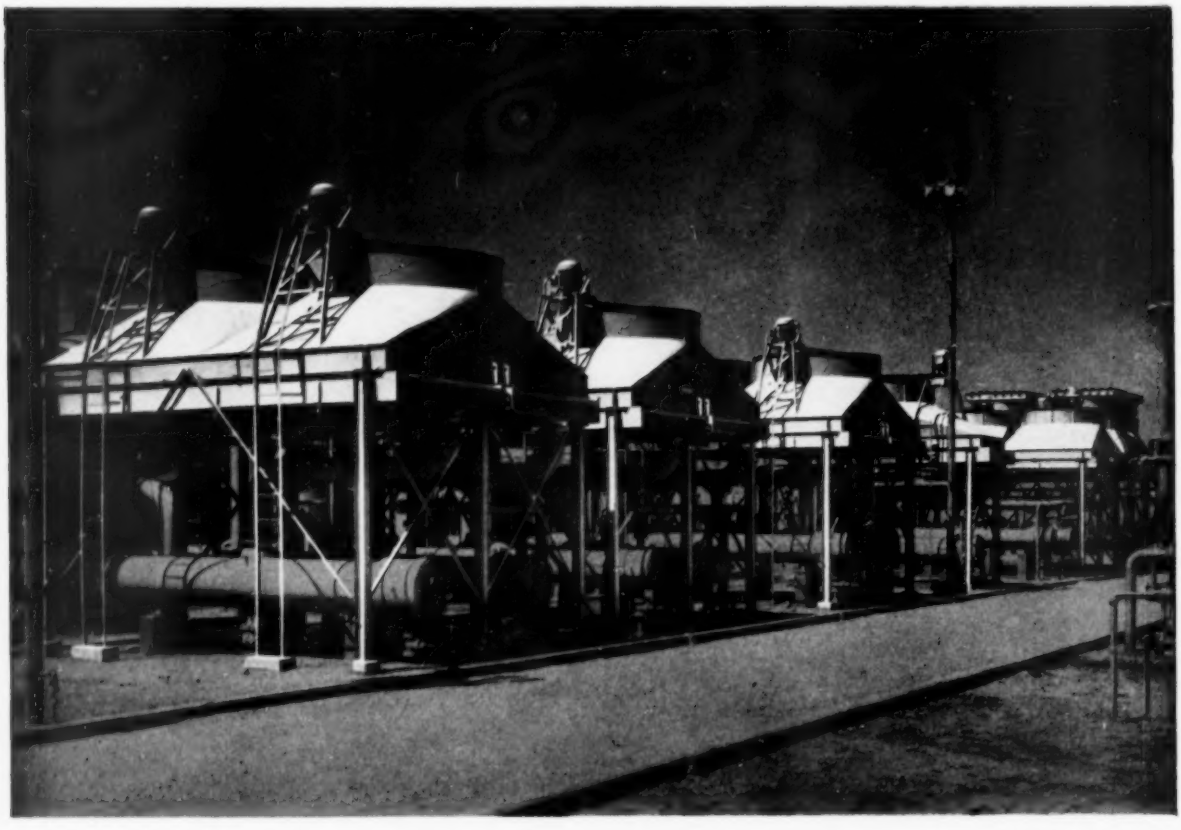

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Improving transportation is also a two-handed affair. One "hand" is the automotive industry. The other is the petroleum industry. Again and again, progress in one has been made practical by a complementary development in the other.

For example, it was the proved ability of the oil industry to provide high octane fuels, through improved refining methods and the use of "Ethyl" antiknock compounds, that prepared the way for higher compression engines. And to prove

(*Continued on next page*)

Printed in U. S. A.

Why is automotive progress like a man washing his hands?

*(Continued from preceding page)*

that it works both ways, the engineering genius of the automobile industry took full advantage of better gasolines to produce more and more efficient engines.

Ethyl people, recognizing this interdependence between engines and fuels, have made it the keynote of Ethyl's research and cooperative projects for the past 30 years.

We hesitate to predict what future progress will bring, but one thing is certain —that this progress will be the result of two of America's greatest industries working hand in hand. And Ethyl research people will continue to work with both industries and to serve in a very special way as liaison between them on problems of fuels and engines.

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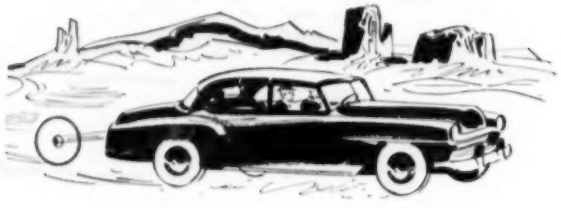

Every year Ethyl buys a representative group of new cars in order to give the petroleum industry full information as to the octane requirements of these cars.

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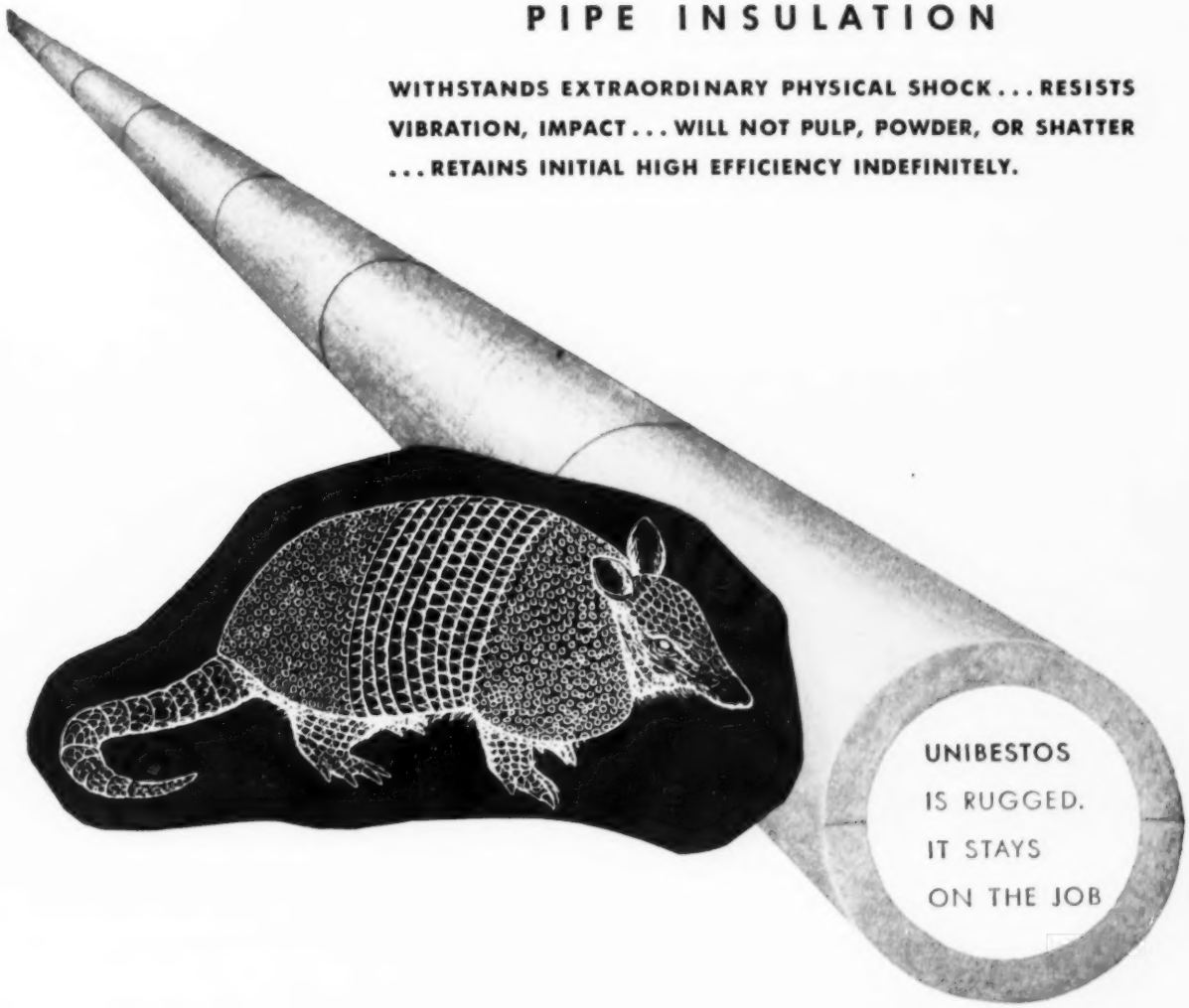


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Covering petroleum and petrochemical research and the design, construction, management, operation and maintenance of plants processing hydrocarbon materials into fuels lubricants and chemicals.

November, 1953
Vol. 8, No. 11

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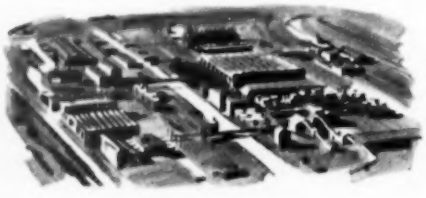

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# Publisher's Page

## *Collectively We Stick Out Our Neck*

THE extent of corrosion damage in refineries is elusive and makes a most controversial subject, PETROLEUM PROCESSING editors have learned. The importance of the corrosion problem is a ready topic of conversation. However, few persons will even hazard a guess as to its cost to refiners. And it is 25 years since any previous study was made.

Nothing daunted, our Editors set out to interview many oil company technologists and other authorities, to see if they could arrive at an acceptable figure for the cost of corrosion in refineries. Such knowledge is necessary to a more intelligent attack upon the problem. Early in our work we ran across the trail of another study on the same subject, being sponsored by the Committee on Refinery Equipment of the API Refining Division. We continued our study independently, in the hope that two sets of figures, even if some distance apart, might be more impressive than one.

It is with some trepidation that the results of the PETROLEUM PROCESSING survey are published in this issue, beginning on pg. 1685. The cost data of the API group may be at considerable variance with our own data. Some readers, individually, may have sound reasons for disagreeing with, or supporting, our figures. In either case, the Editors would be thankful for a letter.

The data on corrosion losses may be controversial. But of this PETROLEUM PROCESSING Editors are sure: Whatever figure is accepted, it will be startling enough to stir many companies to greater effort to reduce their own losses from this cause.

Virgil Guthrie

For the Editors

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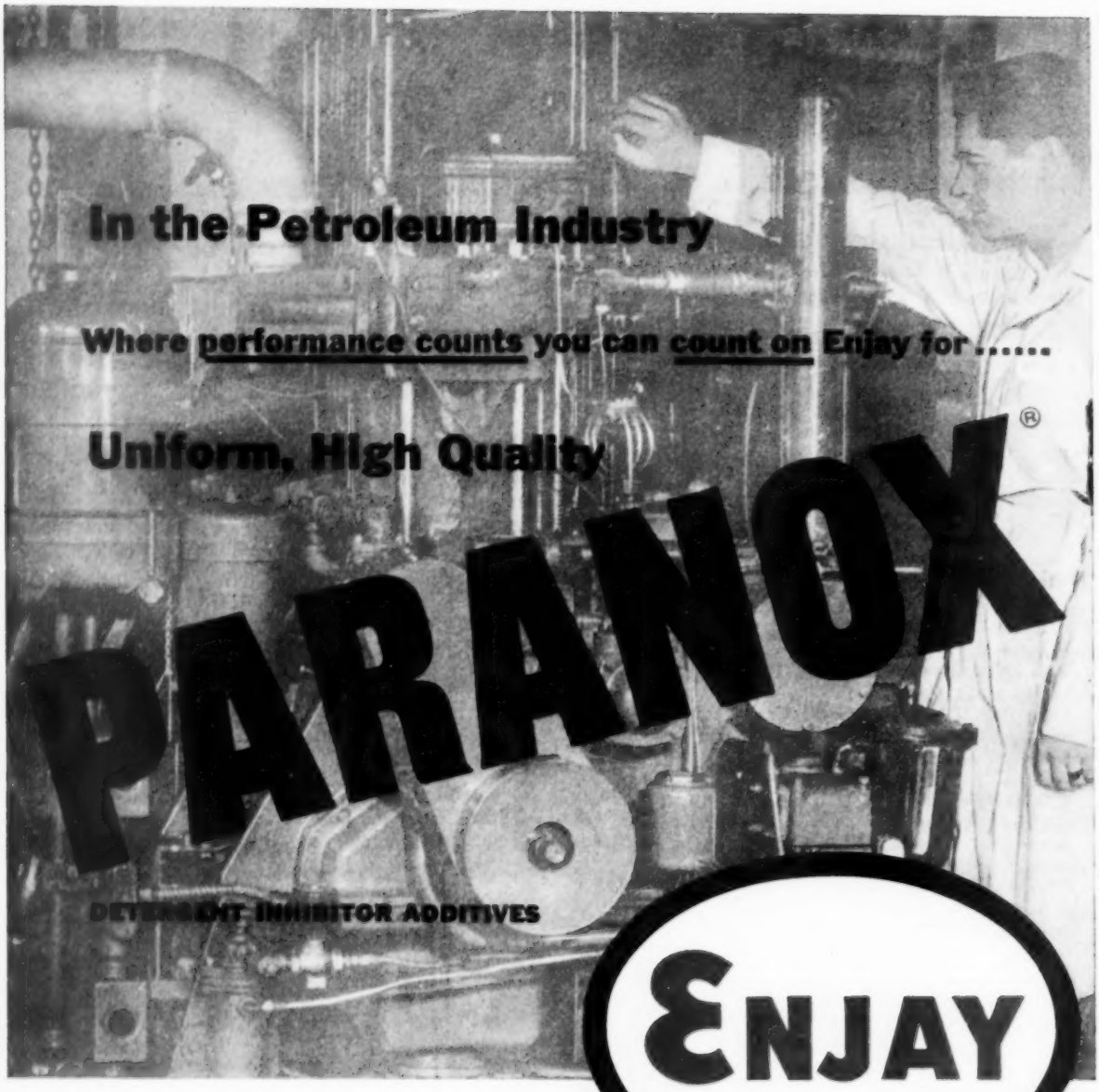


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| Isopropyl Ether | Dicyclopentadiene | Isopropyl Ether |
| Reference Fuels | Naphthenic Acids | Tripropylene |
| | Iso-Octyl Alcohol | Tetrapropylene |
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# What's Happening...

## *In Refinery Expansion*

. . . **Capital expenditures for processing facilities** will be increased by nearly 17% in 1954, according to a survey of 15 large integrated oil companies conducted early this month by *Oilgram News*. Data furnished by the companies, who represent about 54% of total U. S. refining capacity, indicates their probable capital expenditures for new manufacturing facilities in 1954 will be $442,801,000, as compared to an estimated 1953 outlay by the same companies of $379,177,000. Among same companies, capital expenditures in 1954 are expected to decline 2.5% for production and 53.6% for transportation, but to rise 11% for marketing.

. . . **Revised expansion goal for petroleum refining** calls for adding 400,000 b/d of new capacity in 1954 and another 250,000 b/d in 1955—to reach a total capacity of 8,750,000 b/d by Jan. 1, 1956. Figures were set up by Petroleum Administration for Defense, and agreed to by Office of Defense Mobilization.

. . . **Natural gas liquids processing capacity goals** have also been set—200,000 b/d of net capacity in both 1954 and 1955, to reach a total of 1,280,000 b/d by Jan. 1, 1956.

. . . **Mohawk Petroleum Co.** has ordered a 2,400 b/d Atlantic catalytic reforming unit for its 11,000 b/d refinery at Bakersfield, Calif., and signed a contract with Ralph M. Parsons Co. to build the $600,000 project. Completion is set for next spring.

. . . **Pan-Am Southern Corp.** will install a fixed-bed hydroforming unit at its El Dorado, Ark., refinery. The Lummus Co. is building the new unit, construction of which started last month. Completion is scheduled for next summer. The unit will be the first of its kind in the U. S., and will incorporate new design features as well as a catalyst developed by the Research Dept. of Indiana Standard, Pan-Am's parent company. No capacity figure has been revealed. Pan-Am is currently installing a new Fluid hydroformer at its Destrehan, La., refinery of 2,000 b/d capacity.

. . . **Caminol Co.** reports a $200,000 modernization program at its 3,300 b/d refinery at Hanford, Calif., including a new polymerization plant and new laboratory.

. . . **Hancock Oil Co.'s** projected Thermofor Catalytic Cracking unit at Long Beach, Calif., will have a charge capacity of 4,200 b/d. Overall refinery improvement program also includes a 350 b/d polymerization unit, and is expected to take a year for completion after contracts have been awarded. Total cost is estimated at $4,000,000.

. . . **The Texas Co.** plans to boost capacity of its El Paso, Texas, refinery to about double its present 5,500 b/d level, and also to modernize it with the addition of Fluid catalytic cracking, catalytic reforming, delayed coking and catalytic polymerization. A similar program is underway at the company's Amarillo, Texas, refinery (see "What's Happening," May '53, p. 623).

. . . **Quaker State Oil Refining Corp.** has begun construction of a new lube oil packaging plant at Portland, Ore. The new plant will have storage capacity of 750,000 gal., and a daily output of 25,000 gal. in quart cans—plus additional facilities for larger containers. Shipments of finished lubes will be made in tankers direct from Quaker State's Pennsylvania refineries. Contract for building the $250,000 plant was awarded C. M. Corkum Co. of Portland, with completion expected next April.

. . . **Progas of Canada** will install two portable gas processing plants in western Canada in the next few months, at an estimated cost of $1,000,000. One unit will be located in the Acheson Field near Edmonton, Alberta, and the other at Big Valley, between Edmonton and Calgary—with both to be in operation by next June or sooner. No figures on capacity have been released, but both plants will produce LPG and natural gasoline. Company name was just recently changed to Progas of Canada from Canadian Palmer Stendel Oil Corp.

. . . **McColl-Frontenac Oil Co.** plans to increase capacity of its present 5,500 b/d refinery at Edmonton to 11,000 b/d. Details as to type and size of new units to be installed have not been released, but completion is expected in late '54 or early '55.

. . . **New petroleum processing plant expansions** to look for, as indicated by rapid tax amortizations announced last month:

Atlantic Refining Co., $3,158,080 for 8,000 b/d catalytic reformer at Port Arthur, Tex.

Bay Refining Co., $2,847,708 for 6,000 b/d catalytic cracking unit and 300 b/d polymerization unit to process an additional 4,000 b/d of crude at Bay City, Mich.

Esso Standard Oil Co., $17,850,000 for 27,700 b/d catalytic reforming unit at Baton Rouge, La.

Pan-Am Southern Corp., $2,900,000 for 7,200 b/d catalytic reformer at El Dorado, Ark.

Pan American Refining Corp., $3,180,000 for avgas alkylate facilities at Yorktown, Va.

Phillips Petroleum Co., $5,424,000 for 16,000 b/d catalytic reforming unit at Sweeney, Tex.

Reef Fields Gasoline Corp., $236,205 for refining facilities in Howard and Borden Counties, Tex.

Rowan and Hope, $440,570 for natural gas processing plant at Sweetwater, Tex.

Westoil Terminals Co., $742,000 for refining facilities at San Pedro, Calif.

*Information on these pages is obtained through the nation-wide news coverage service of* PLATT'S OILGRAM NEWS

## in Petrochemicals

. . . **Pan-Am Southern Corp.** may be contemplating more activity in the field of petrochemicals. Company announcements concerned its new catalytic reforming unit at El Dorado, Ark. (see item under "Refinery Expansion" above), point out that "although no operation of this type is planned at present, the hydroformer lends itself to conversion for production of petrochemicals like benzene and toluene."

. . . **Dow Chemical Co.** is going to underground storage for its petrochemical raw materials—butane and propane. Two salt dome cavities with a total capacity of about 300,000 bbls. are now being prepared for such use—and will help iron out the peaks and valleys of supply.

. . . **Standard Oil Co. (Ohio)** may soon be the newest refiner to get into petrochemicals. Company president C. T. Foster last month stated that his firm has been studying the economics of petrochemicals for some time "with the expectation that developments in our manufacturing processes as well as those in the field of petrochemicals will present at some point an attractive opportunity for entry in this field." Foster then added: "This point seems to be moving closer and our plans are becoming more tangible."

. . . **First West German petrochemical plant** to utilize refinery gases for making ethylene and ethyl benzene will be built in Wesseling area, between Cologne and Bonn. Operation is going under name of Rheinische Olefinwerke GmbH., and is a mutual project of German Shell AG, Hamburg, and Badischen Anilin & Sodafabrik AG, Ludwigshafen. Production will start in 1955.

## in Markets and Prices

. . . **Unseasonable decline in natural gasoline prices** marked the month of October. Prices slumped 0.875¢ a gal., to 5.5¢, Breckenridge, and 5¢, Group 3. Other unseasonable weakness was cited in prices for propane and butane in the Mid-Continent and the Southwest.

. . . **More in line with expectations for the month** were declines in motor gasoline prices for cargo loading at the Gulf, distillate prices up in the East, and No. 6 up 5¢ to $1.25 for Group 3 basis shipments.

At the Gulf, quotations for spot cargo lots were lower in amounts ranging from 0.25¢ to 0.5¢ a gal. Regular grade, 87 octane, was quoted at 11.5¢. In Ohio, because of "current market conditions," Standard of Ohio made a general cut of 0.2¢ a gal. in its regular-grade ("X-tane") prices at company-owned stations.

In the East, Sun Oil Co. reported an advance of 0.25¢ a gal. in its prices for distillates at terminals from Maine to Virginia. Sun was last major marketer in the East to advance distillate prices since the price of crude was hiked last June.

. . . **Warm weather put an unusually severe strain** on storage facilities of many refiners and terminal operators. Bunching up of inventories early in the heating season forced reduced refinery runs that could be much needed toward the end of the winter. This condition was pointed up in an East Coast report that one major refiner could "see enough" supply only through February, given a "normal" winter.

. . . **Lube oil inventories were reduced substantially,** but prices for many grades continued weak. A western Pennsylvania refiner slashed his quotations 4¢ for bright stock and 2¢ for neutrals. His new price for 25 P.T. bright stock was 19¢.

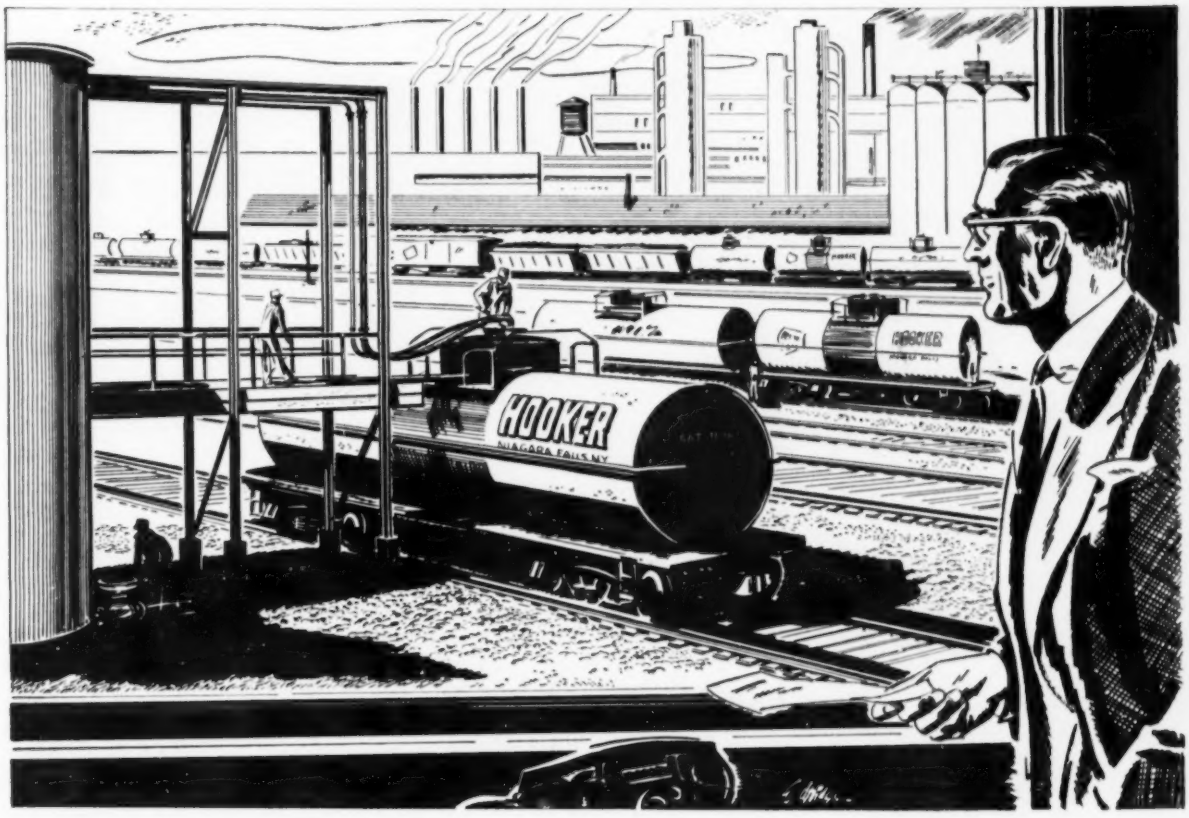
## Looking Ahead

. . . **Higher Octanes Sooner:** Rapid adoption by refiners of catalytic reforming, along with catalytic cracking, makes it practical to supply commercial fuels for 10-1 compression engines, two authorities recently stated. E. V. Murphee, president of Standard Oil Development Co., believes that premium gasolines of 99.7 Research octane and regular fuels of 93.7 octane will be available by 1961, with 98 octane being given as the requirement for a 10-1 compression engine. W. M. Holaday, director of Socony-Vacuum Laboratories, also thinks that improvements in engine design and fuel manufacturing techniques make it practical to think in terms of 98 octane and 10-1 compression.

. . . **Sun Oil Co.,** long a staunch supporter of selling only one grade of motor gasoline, reportedly is planning to come out with a second grade of higher octane rating than present grade.

. . . **No More for L.A.:** There is growing speculation that there'll be no more refinery expansion in Los Angeles basin once current projects are completed, but that future growth will be in northern California or Pacific Northwest. Industry leaders are getting sore at the abusive criticism poured on refiners during smog spells, especially since politicians have entered the act. Even though industry admits to contribution and has done everything officials have requested, and despite fact official reports cite other major smog sources, oil industry is still No. 1 target. One fed-up executive asserted, "I'm sorry we can't close our Los Angeles refinery and move someplace where we're welcome—like Washington. I doubt that we'll spend any more money on expansion in Los Angeles."

. . . **New Technical Abstract Service** of API Division of Refining is scheduled to start in January. It will be published weekly, and will cover 100 petroleum and chemical publications. Basic subscription cost, which provides five copies of each weekly issue, is $3,000 a year. Multilith master sheets of the bulletin pages will be available to subscribers (10¢ a master) for printing file cards of the abstracts. Louis C. Stork is editor, located at API, 50 West 50th St., New York.

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Uniformity, from shipment to shipment, is the result of close quality checking at Hooker. More than a score of inspections and analyses safeguard the uniformity of the Hooker caustic you buy.

Do you agree, with leading companies in 30 different industries, that this is a good reason to *standardize* on Hooker caustic soda?

If you do, a letter or a phone call to the nearest Hooker plant or office will quickly bring you the product data and other facts you need to make your decision.

## You can *standardize* on Hooker Caustic Soda

| Forms | Grades | Containers |
|---|---|---|
| Liquid 50% | Standard grade | Tank cars |
| Liquid 73% | High grade | Tank wagons |
| Flake | Rayon grade | Barges |
| Special fine flakes | | Drums |
| Solid | | |

*From the Salt of the Earth*

**HOOKER ELECTROCHEMICAL COMPANY**

**4713 BUFFALO AVENUE, NIAGARA FALLS, N. Y.**

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HOOKER CHEMICALS

# measure oxygen direct

## paramagnetic method of measurement extremely accurate in analyzing industrial gases

Oxygen is unique among other common gases in that it is highly paramagnetic (attracted into a magnetic field). This property of oxygen is the basis of the operation of the Hays Magno-Therm Analyzer in the analysis of industrial gases.

### application

Hundreds of companies are using the Hays Magno-Therm $O_2$ Analyzer and Recorder in applications from revivification of $SO_2$ removers in manufactured gas industry and regeneration of catalysts in oil refineries to mixing air with propane to get substitute fuel. Boiler plants use it as a combustion guide because it is the only means of getting an undistorted picture of excess air.

*Write today for bulletin 52-829-56 and get complete details.*

**ANALYZER**

Highly sensitive to changes in oxygen content.

Rapid response to changes in oxygen content.

No liquid or gaseous fuel required to be added to gas sample.

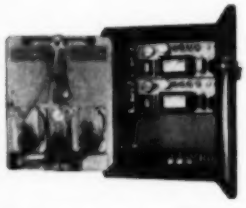
No chemicals required.

High accuracy maintained.

Not affected by wide variation in rate of flow of gas sample.

Rugged construction. No delicate or moving parts.

Easily installed — no special fittings required.



**RECORDER**

Self-balancing bridge circuit assures accurate, permanent calibration.

Electronic amplifier has no moving parts. High sensitivity. Rugged.

Immediate response—analyzer is continuously connected to recording pen drive motor.

As many as four analyses can be recorded on the same chart.

Range can be changed easily in the field.

Isolating transformer for each amplifier removes line interference from bridge circuit.

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Automatic Combustion Control Boiler Panels • $CO_2$ Recorders Veriflow Meters and Veritrol Gas Analyzers • Draft Gages Combustion Test Sets Electronic Oxygen Recorders Electronic Flowmeters Electronic Feed Water Controls Miniature Remote Indicators

THE hays CORPORATION

MICHIGAN CITY, 23 INDIANA

## Natural Fibers May Get Help From Top Competitor—Petrochemicals

COTTON shows promise of a come-back from inroads resulting from the several synthetic "miracle fibers" with the reported successful development of a new series of fibers produced by treating it with acrylonitrile by the Institute of Textile Technology at Charlottsville, Va.

Cyanoethylation of cotton produces a material with the feel and appearance of the original plus increased receptiveness to dyes, permanent resistance to mildew and greater strength retention after exposure to wet and dry heat.[1]

Cotton figured in another recent development, this time by the U. S. Dept. of Agriculture's Southern Regional Research Laboratory at New Orleans. Treating cotton with anhydrous liquid monoethylamine, another petrochemical, improves toughness, impact strength dyeing capacity and chemical reactivity without affecting its already desirable properties. The amine apparently reduces crystallinity by 20-30% and is removed after treatment with solvents, in such a manner that effects of the treatment are not cancelled.

Both these developments in cotton may become important to the oil industry. Cotton already finds itself in plant use as a filtering medium, for instance, and one of the big maintenance costs results from wear of the filter cloth. The same is true of chemical plants. Also of interest to both is the treating chemicals, which may readily be produced from petroleum raw materials and in some instances already are.

From the textile standpoint, one of the objections to the synthetic fibers has been their relatively high cost when compared to more conventional materials. Cotton, on the other hand, has remained relatively inexpensive. Now, with several possibilities for an in-between cost material made from it, demand for acrylonitrile and monoethylamine can be expected to reflect any improvement in cotton's situation. —D.P.T.

*(1) Chemical Week, P. 24, Sept. 5, '53—*

## Will Air-Conditioned Autos Break The Bottleneck on Fuel Volatility?

REFINERS may someday be able to market higher vapor pressure automotive fuels than they are presently accustomed to, or state regulations will permit, now that Detroit auto makers at last appear to be giving the vapor lock problem more than passing attention.

Refiners and natural gasoline producers have long been wanting to see motor fuel vapor pressures go above present levels. But evidence is available in ample quantity to prove that automotive fuel system designs are not as good as they should be, and won't tolerate a more volatile fuel.

**What's the cause?** What is making the automotive industry designers to sit up and take notice that their fuel systems need redesigning, and to entertain suspicions that present-day carburetor principles might be obsolete? In a word, it's "air-conditioning."

Although air-conditioning hasn't been pushed by auto makers, sales indicate that the public wants it—and the demand apparently is not restricted geographically. There is said to be serious consideration among some auto makers to start promoting air-conditioned cars. The net result is that more and more air-conditioned cars will likely be on the road.

**Unfortunately,** air-conditioning creates the problem of disposing of the heat removed from the car interior; commonest practice is to place the condenser coil under the hood in front of the radiator. As a result, the engine radiator's efficiency is seriously impaired, and under-hood temperatures are boosted considerably. Simultaneously, the chances of the engine experiencing vapor lock are greatly increased. Customers complain about car performance and fuel quality—and that hurts everybody.

There is only so much which can be done to improve present fuel systems ahead of the carburetor. But vapor lock can also occur *in* the carburetor, and this device itself is under close scrutiny. Some new developments in carburetion are in the making, it is said, and probably some research investigations to increase vapor pressure tolerance.

**This will be good news to refiners,** natural gasoline manufacturers, conservation authorities and the auto driver, if higher vapor pressures can be permitted in automotive fuels. Refiners already have warned that inclusion of more light ends will be necessary if modern processing is used to greatest advantage, and if demand keeps going up. Natural gasoline manufacturers need a market for the light ends which conservation authorities rightfully demand must be recovered from oil and gas fields, and which otherwise must be flared or kept in expensive storage. And the public needs a vacation from the annoyance of vapor lock; so do oil company sales departments. —D.P.T.

## Electric Membrane Shows Promise For Demineralizing Brackish Water

LARGE-VOLUME demineralization of brackish water through the use of an electric membrane is beginning to show promise from the economic standpoint, although cost will be high in comparison with usual water-treating expense.

According to a recent report of investigative work by Ionics, Inc.,[1] a membrane material has been developed which will selectively pass cations in the presence of anions or vice-versa. The membrane is not yet in commercial use for purifying brackish waters, and its developers are more sure now of operating costs than capital investment. Indications are that the cost will be one to several dollars per thousand gallons instead of cents in comparison with usual softening procedures.

The idea of a semi-permeable membrane is not new as any chemist can prove in a short time. The wrinkle

here is two membranes forming the two principal walls of a cell, one of which is permeable to anions only, and the other to cations only. On either side of this cell is another cell in which the migrating ions collect. The brackish water (1000 to 10,000 ppm. of solids) is contained in all three cells. Like the familiar high-voltage radio battery, this basic unit of three-cells can be combined in series using as many multiples and direct current applied across the whole system.

In such an arrangement, a cation-permeable membrane would form one side of the waste-water chamber, and an anion-permeable membrane the other side. Every alternate cell, then, would produce demineralized water. Electrodes would be needed only for the end cells rejecting, respectively, anions and cations. Total resistance across the system would progressively increase as demineralization proceeded and would tend to approach that of distilled water as conductivity decreased.

The speed with which the ions move from the membrane-lined compartment into the adjacent unlined compartments is a function of the applied power, while the power requirements, in turn, are based on the quantity of demineralization demanded. It is possible to make the process continuous.

As demineralization of water in the lined cells proceeds, the water in the two adjacent, unlined cells becomes progressively more and more brackish. Eventually it must be discarded, the rate of discharge being dictated by process economics.

This method is not to be confused with demineralization by means of ion-exchange resins. No cyclic treatment of the membranes is required beyond physical care to prevent their rupture, whereas the resins must be treated chemically to restore their demineralizing capacity; i.e., with acid and alkali, respectively.

The only other known basic method of demineralizing brackish water is by distillation in its many forms. Of these, vapor pressure compression distillation reportedly is the least expensive from the energy consumption standpoint. —D.P.T.

(1) Kirkham, T. A. and Katz, W. E., "The Promise of Ionics' Electric Membrane Demineralization for Brackish Waters," presented before South Texas Section Am. Inst. Chem. Engineers, Galveston, Oct. 16, 1953.

## All-Electronic Controlled Plants Are Here Now, Instrument Men Say

SIGNS are stronger than ever of an upsurge in the use of electric and electronic instrumentation in the petroleum processing industries. For instance:

1—At least four U.S. refineries or refinery units now under construction will wind up as all-electronically controlled plants. Although the companies involved have preferred anonymity, they have not denied the persistent and well-founded rumors. Two installations are on the West Coast: the other two are in the Midwest.

2—One of the busiest men at the recent Instrument Society of America Conference in Chicago was W. T. Marchment of Evershed & Vignoles Ltd., London, England. He had presented a paper on "The Application of Electronic Process Control to Oil Refineries," which covered an installation for Anglo-Iranian Oil Co. American instrument experts with oil companies, engineering contractors, and electronic instrument makers all cornered Marchment for long talks.

3—The new 1953 "Red Book," the National Fire Codes, just revised after three years now legalizes the use of thermocouples in refineries. Ludicrous though this may sound, oil company instrument men see it as a good start on an even more liberal code by 1956, the time of the next revision.

4—Continued success of several foreign refineries using electronic control, coupled with Europe's traditionally more realistic attitude toward electrical devices in the refinery, has led to similarly more realistic approaches in the U.S. For example, the British attitude has long been to allow any equipment which is "intrinsically safe."

Processors in this country can expect to see soon some institutional-sponsored research to prove the results British and Continental processors have already obtained.

An example of the kind of electronic control system found satisfactory by the British is given in Mr. Marchment's paper. The principle of operation of the transmission system is as follows.

The transmitter is a torque balancing device in which the torque exerted by the originating movement is balanced by the torque of a coil operating in the cathode circuit of an electron tube. The balancing coil is connected in series with simple milliammeter movements in indicators, recorders, and controllers, which therefore receive signals proportional to the measured quantity.

When in balance, a contact connected to the grid of the tube and carried by the balancing coil is in a neutral position between two fixed bias contacts, the voltage on the grid being maintained by a storage capacitor between grid and cathode.

Any unbalance created by a change in the quantity being measured causes the grid contact to touch the positive or negative bias contact, thereby raising or lowering the plate current until the system is again in balance.

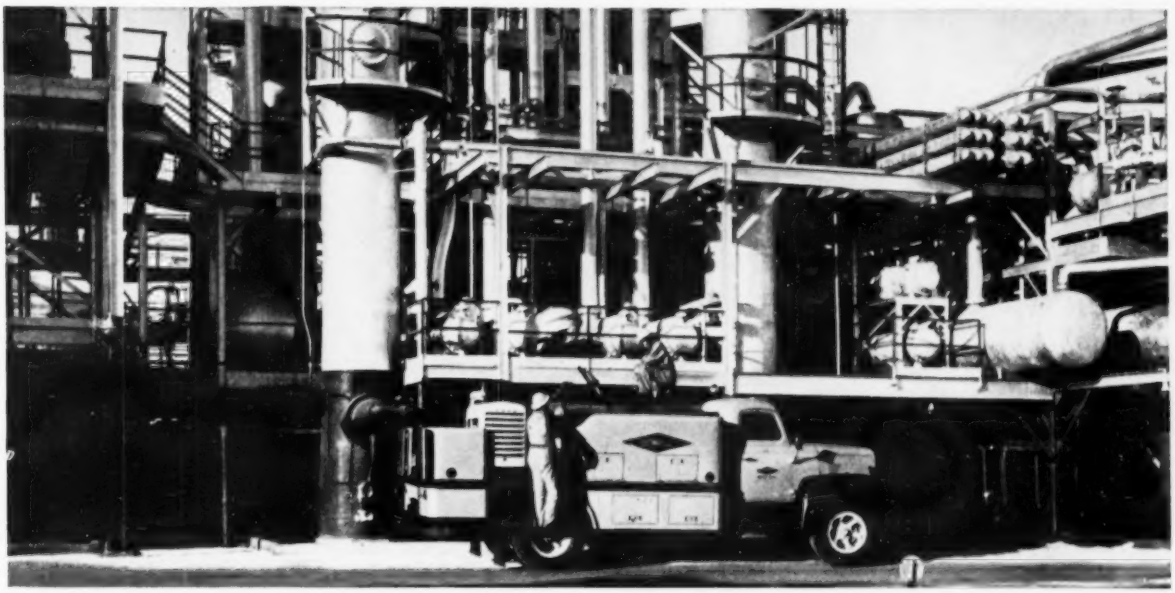
The transmitter compensates automatically for any change in supply voltage, circuit resistance, or frequency.

The system is used for controlling, recording, or indicating such variables as level, specific gravity, flow, temperature. Its first, full scale application was on an $SO_2$ extraction plant. It will eventually go into rerun, catalytic polymerization, and topping operations.

The hazard of electricity, long-regarded as an almost insurmountable obstacle in the U.S., is now said to be highly overrated. Advantages of electricity in the form of greater efficiency through high-speed transmission of signals when compared to pneumatic transmission far outweigh any shortcomings, it is said. —W.C.U.

# TOWER CAPACITY RESTORED IN ONE DAY BY CHEMICAL CLEANING

## Through-put increased from 500 to 800 gallons per minute by Dowell Service



The capacity of a fractionating bubble-cap tower, operated by a southern chemical company, had dropped from 800 to 500 gallons per minute. Heavy deposits covered the traps and clogged the bubble-caps. Dowell engineers analyzed these deposits and found them to be iron sulphides, oxides and organic material.

Dowell Service removed these deposits from the tower in only one day with specially prepared liquid solvents. Result: the tower was restored to its original 800 g.p.m. capacity.

In the Dowell method of chemical cleaning, solvents are applied according to the technique demanded by the job: filling, spraying, jetting, cascading or vaporizing. Being liquid, they will go wherever steam or water will flow, reaching surfaces inaccessible to other cleaning methods. No special scaffolding is required. Dismantling and downtime are kept to a minimum. Experienced Dowell engineers do the job for you using Dowell-designed pump trucks and control equipment which are brought right into your plant.

Towers are just one of hundreds of pieces of industrial equipment which can be cleaned chemically by Dowell Service. For complete information and estimates on the cleaning of your equipment, call the nearest Dowell office, or write directly to Tulsa, Dept. K32.

# *DOWELL SERVICE*

*Over 100 Offices to Serve You with Chemical Cleaning for:*

Boilers • Condensers • Heat Exchangers • Cooling Systems
Pipe Lines • Piping Systems • Gas Washers • Process Towers
Process Equipment • Evaporators • Filter Beds • Tanks

*Chemical Services for Oil, Gas and Water Wells*

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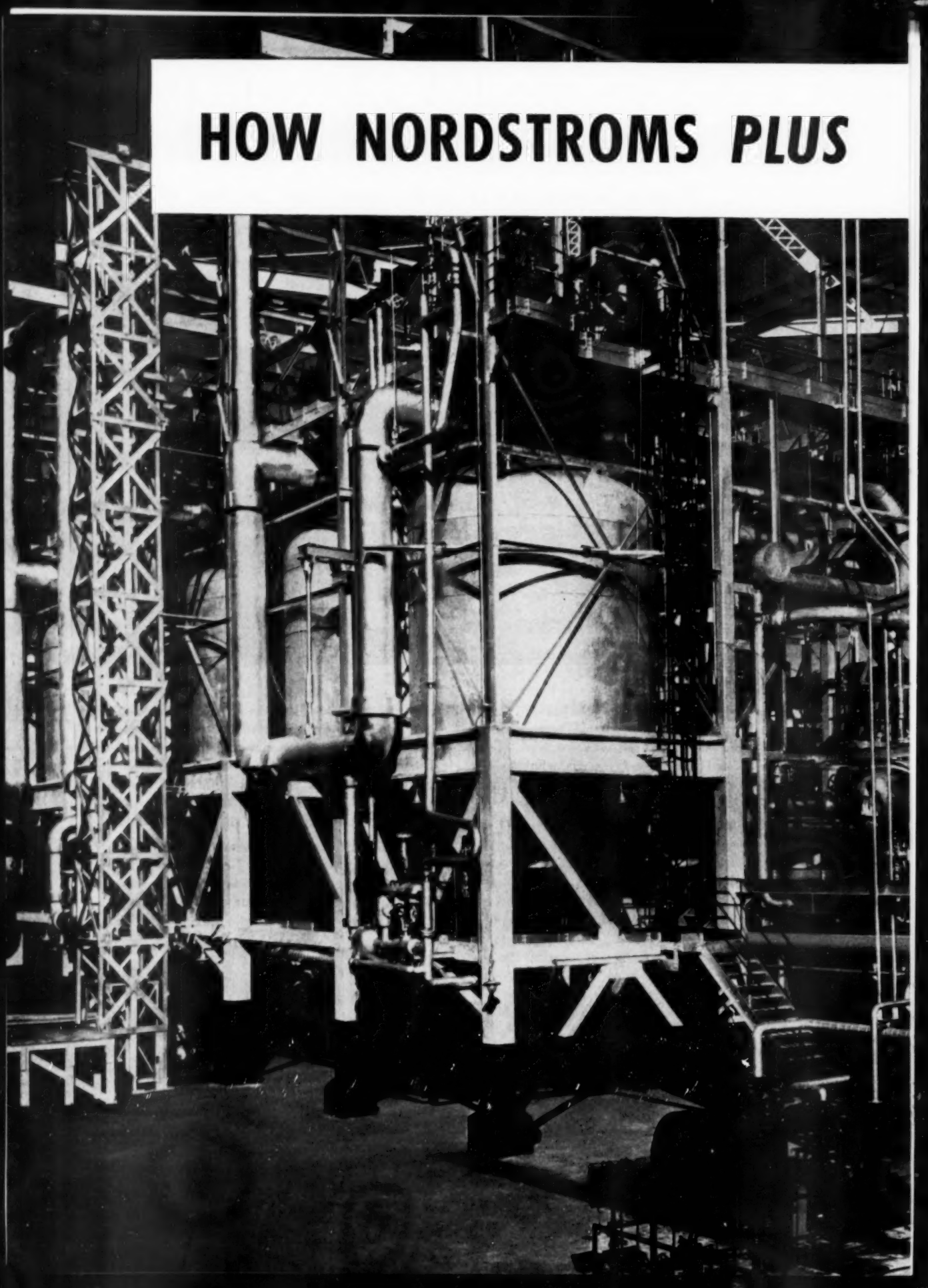
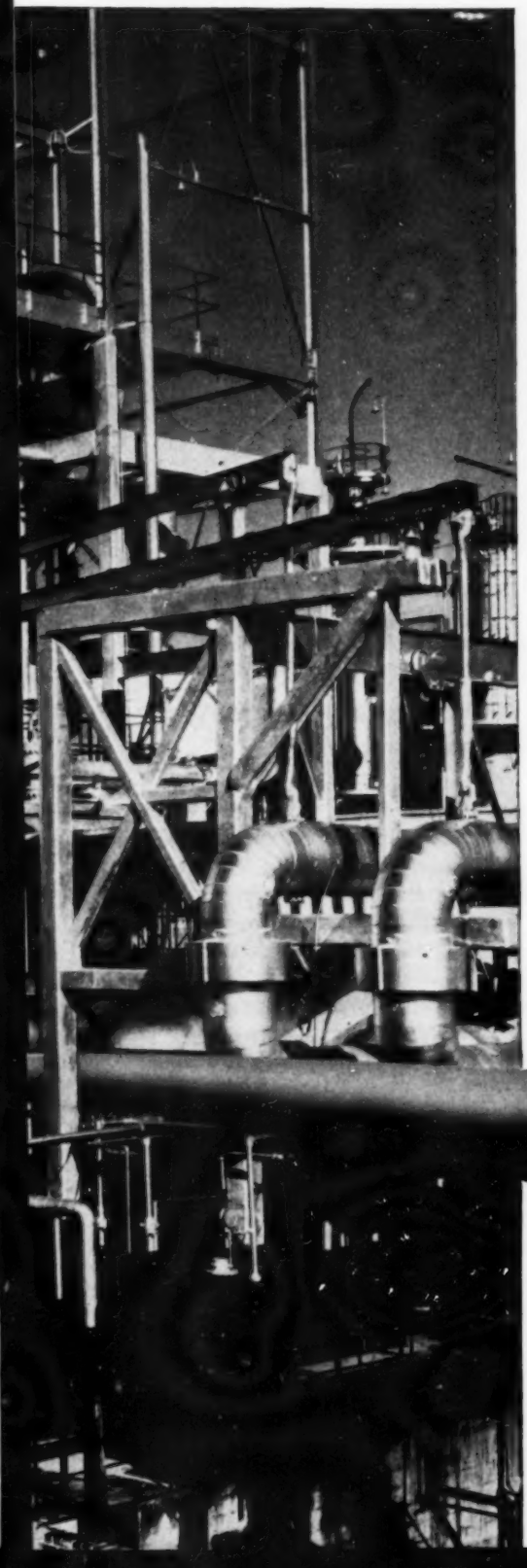
THE DOW CHEMICAL COMPANY

 (*To obtain more data on advertised products see page* 1760) 

# HOW NORDSTROMS *PLUS*



# Lubricaut Keep Plants "On Stream"



A modern refinery or chemical plant costs several million dollars to build. Most are designed to operate constantly; most must if they are to pay out.

But . . .

Valve failure at a key point may shut down whole units, or perhaps a whole plant.

Under some circumstances, almost any mechanical equipment can break down, of course, but there is far less likelihood of a Nordstrom giving trouble in most services than any other type of valve.

Why? . . .

**NORDSTROM VALVES ARE LUBRICATED.** A film of plastic lubricant spreads around the valve ports to seal tighter than metal-to-metal contact. At the same time the lubricant protects seating areas against wear and galling, and it keeps the valve ready to turn quickly.

**NOPDSTROM VALVES CAN BE MAINTAINED IN SERVICE.** You don't have to shut down a line to repack Nordstroms. The seat can be renewed by loosening the stop and reversing the plug 180 degrees. The valve can be relubricated under pressure at any time. And because of the design, there is far less chance of major damage to stem, plug or body, so that it is rare, indeed, that a properly maintained Nordstrom valve has to be taken out of service for repair.

**NORDSTROM VALVES HAVE STRAIGHT-THROUGH FLOW.** With no body or bonnet areas to catch sediment or cause turbulence, wear is reduced and choking or damming up is impossible in most services.

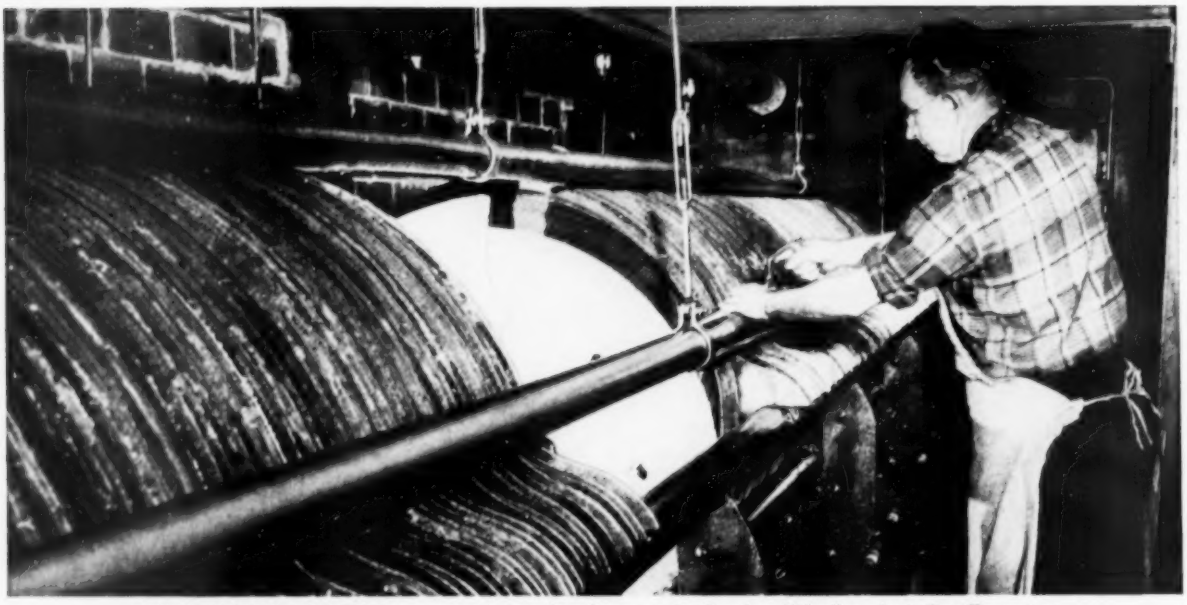
There is only one way to save money on valves—buy the right ones, buy the best ones in the first place, and then give them proper care. No valve is a cheap valve if it fails.

Nordstrom valves are not always the cheapest in original cost, but over the long pull they always are. And, there's a *right* Nordstrom valve—the right size, right corrosion-resistant material, right body pattern, and right pressure—for nearly every process requirement. Let your Nordstrom sales engineer show you, or write for a Nordstrom Catalog to Rockwell Manufacturing Company, Pittsburgh 8, Pa. *Canadian Licensee: Peacock Brothers Limited.*

**ROCKWELL Built** Nordstrom Valves

*Lubricant-Sealed for Positive Shut-Off*

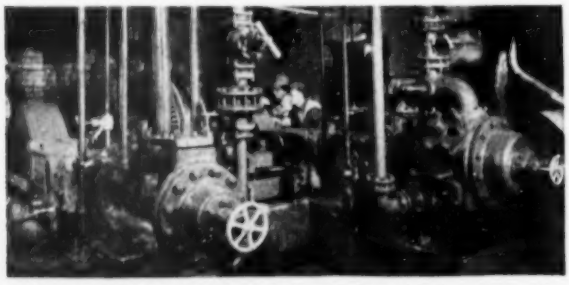
Another ROCKWELL product



**WAX PRESSES ARE STRIPPED** once every twenty-four hours at the Freedom-Valvoline plant. Paraffin wastes are separated from wax distillate by chilling the distillate directly and removing the wax with a filter press.

# Worthington equipment marks quarter-century at Freedom-Valvoline

**WORTHINGTON REFRIGERATION EQUIPMENT** at Freedom is used for dewaxing petroleum by two methods. In addition to the filter press method, wax is removed by chilling naptha solutions to precipitate the waxes and then centrifuging.



**THIS WORTHINGTON AMMONIA COMPRESSOR** has been operating in dewaxing service at Freedom since 1928.

## *Refrigeration units operate continuously in dewaxing service*

Reliable, continuous operation of refrigeration equipment is a must in the processing of high-grade motor oils.

That's why the Freedom-Valvoline Oil Company has been using Worthington refrigeration equipment—ammonia compressors, boosters, brine pumps and heat exchangers—in dewaxing service at their plant in Freedom, Pa., for more than 25 years.

For more than half a century, Worthington engineered refrigeration installations have been serving leaders in industry everywhere. Today, the complete Worthington line is ready to meet any assignment, large or small. Remember, Worthington systems are all Worthington-*made*, not just Worthington-assembled. In addition to getting a perfectly balanced system, users benefit by Worthington's complete unit responsibility. Get in touch with your nearest Worthington district office, or write to Worthington Corporation, Air Conditioning and Refrigeration Division, Harrison, N. J.

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**WORTHINGTON**

PETROLEUM CHEMICALS DIVISION
# NEWS

November ★ One of a Series of Interest to the Petroleum Industry ★ 1953

When the customer says

"WHY CHANGE OIL?"

## This new Du Pont folder will help your dealers to have a ready answer

The need for oil change at regular intervals has been frequently attacked in the public press. As a result, many motorists resist the service station operators' efforts to protect their cars with regular oil changes.

To help your dealers cope with this situation, Du Pont has prepared a small folder on the main reasons for changing crankcase oil. The copy is short, snappy, and easy to remember. Each point is clearly illustrated by a cartoon drawing.

For sample copies and information on how to obtain the folders for your dealers, write to any Du Pont Petroleum Chemicals Division district office. The title is "When the customer says *'Why Change Oil?'* "

# How much do price and credit influence gasoline buying?

***Du Pont's 4th survey report on consumer gasoline buying habits indicates motorists are not as price conscious as previously believed***

Do "price wars" have any justification? Are credit cards business getters? Do local charge accounts build station or dealer loyalty?

Some of your customers have told us their answers to these important questions. And what they say may have a vital bearing on your future marketing plans. To help marketers solve the riddle of the dollar sign, the Du Pont Petroleum Chemicals Division is now distributing Report No. 4 of its nationwide survey of consumer gasoline buying habits.

**THE INFLUENCE OF PRICE,** credit cards and charge accounts on gasoline purchasing patterns is analyzed in the 4th report in Du Pont's continuing series.

## Cartoon Storyboard for Showing Survey Data at Dealer Meetings

Buying habit statistics are an important ingredient in any sound marketing program. But at a dealer meeting, plain statistics are likely to cause an epidemic of sleeping sickness.

To help you present – graphically and entertainingly – the basic marketing information in the Du Pont Buying Habit Survey, we will be glad to prepare for you a rough cartoon-style storyboard. This can be easily made into an entertaining sound slide film.

The storyboard weaves the factual survey data into a cartoon-style chain of events involving the relationship between dealer and customer. Key facts are put in terms of the dealer's own yardstick of personal experience. And the script is tailored to fit your own brand and individual marketing problems.

Several oil companies are already using sound slide films made from Du Pont-prepared storyboards. They are highly enthusiastic about the results obtained.

The average motorist, the survey found, is well informed on gasoline prices and the price difference between grades. In fact, three out of four said the price they paid for gasoline was generally the same as for competing brands. (And prices reported in the survey agreed with posted prices in the areas studied.)

### "PRICE WARS"

It may surprise some marketing executives to learn that few of the motorists interviewed even recall "price wars." And still fewer switched brands or stations to take advantage of such drastically reduced prices.

And price is no deterrent in the sale

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT

PETROLEUM CHEMICALS DIVISION
NEWS

DU PONT

CONTINUED *Price and Credit*

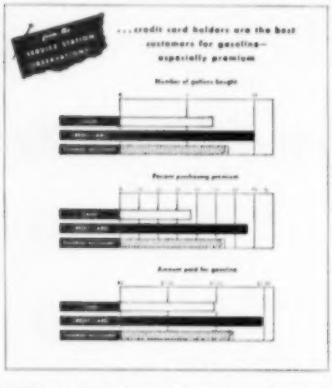
of the better grade of gasoline. Moreover, the frequency of premium purchase is greatest in areas where higher premium prices prevail.

### CREDIT CARDS

The survey shows that 12% of the motorists in the U. S. hold oil company credit cards. But the percentage varies widely in different geographic areas. In the West, for example, nearly 30% hold credit cards. Service station observations show that the possession of a credit card practically assures that it will be used—and used regularly.

Good credit generally denotes a good customer. And this holds true in gasoline marketing as well as in any other business.

Credit cards are used most extensively by the upper income groups, and more than half the credit card holders say they use the card for services and products other than gasoline. Credit card holders are, therefore, in most cases, "best" customers.




**THESE CHARTS** from Report No. 4 of "The Service Station and the Motorist," based on actual service station observations, show that credit card holders are the "best" gasoline customers.

### CHARGE ACCOUNTS

Almost 27% of the motorists interviewed said they have a charge account at a local service station. Point-of-purchase observations show that 14% of gasoline purchases are by charge account.

In contrast to credit cards, charge accounts are largely a personal arrangement between an individual dealer and his customers. And, independent of brand loyalty, a dealer's personal friendship with his customers generally determines the amount of his charge account business.

### QUALITY FACTOR

Only about 10% of the total gasoline market are "price buyers." However, the number of motorists who buy premium because they associate high price with high quality is almost as great.

National in scope, the Du Pont survey is based on 3,100 household interviews and 21,000 observations at 1,193 service stations. The previous three reports covered service station selection and loyalty, brand name recognition and loyalty, and gasoline grade preferences. Future reports will deal with oil and TBA purchases and dealer services.

The information made available to the oil industry through this survey, we believe, will be extremely useful in planning merchandising and promotion programs.

## Eastern District Assistant Manager

**BARRY V. CORNWALL**

BARRY V. CORNWALL, now assistant manager for the Eastern district, joined the Petroleum Chemicals Division in 1952 as technical assistant to the director of sales.

He has been associated with the Du Pont Company since 1929. His first assignment was as a technician in the service laboratory of the Dyestuffs Division. He later became a salesman for anti-freeze and industrial solvents in the Alcohol Division.

Prior to his transfer to the Petroleum Chemicals Division, Mr. Cornwall was assistant sales manager of the Alcohol and Camphor Section.

Born in Winnipeg, Canada, he graduated from Clemson College. During World War II, he served four years in the U. S. Army.

## Storage Tests Recommended For Fuel Oil Additive No. 2

If you have been trying to determine the effectiveness of Fuel Oil Additive No. 2 in your own stocks by an accelerated method, you may have been discouraged by the results.

For a true indication of the effectiveness of Du Pont Fuel Oil Additive No. 2, you cannot depend entirely on accelerated tests. *Storage* tests at temperatures approximating field conditions should be used whenever possible.

However, if actual storage tests take too long to be practical for your purposes, storage tests at a temperature of 110°F. is a good compromise. This accelerates aging enough to give comparisons in a few weeks. But the temperature isn't high enough to invalidate test results.

Samples of Fuel Oil Additive No. 2 for testing are available from any Du Pont Petroleum Chemicals Division district office.

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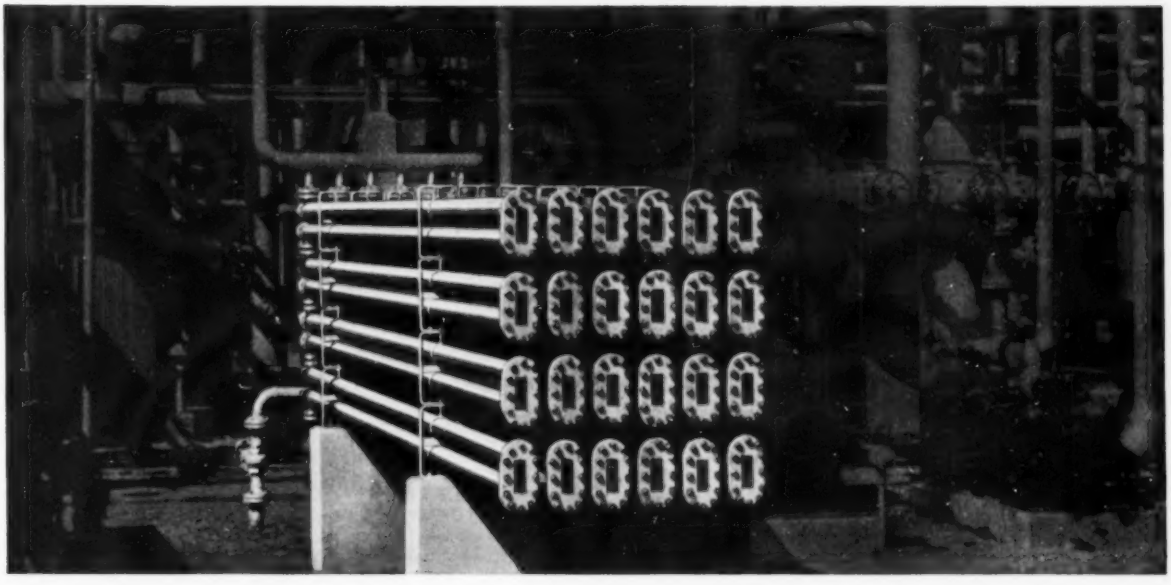
# *Eliminate Down-Time*

## in your plant with



## BROWN FINTUBE *Sectional* HEAT EXCHANGERS

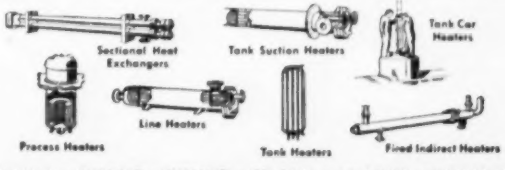
● Simply manifolding an extra parallel stream into a bank of Brown Fintube Heat Exchanger **Sections,** permits one group of sections after another to be taken off-line, and cleaned, while the rest of the unit — always thoroughly clean — carries the exchanger's full rated capacity, year after year, without shut-downs.

This avoids the necessity of carrying a 100% standby unit, to assure continuous operation, as when a "bundle" type heat exchanger is used. It permits the sections to be cleaned as frequently as the duty requires without affecting other parts of the plant. It avoids the loss in efficiency that results from just a few thousandths of an inch of deposit on the tubes; and assures clean surfaces and highly efficient operation at all times.

Eliminating down-time is only one of Brown Fintube's many advantages. Flexibility to meet changing plant requirements; reduced fouling; and prompt delivery are some of the others. Bulletin No. 512 contains full details; and will give you many proven, money-saving ideas! *Send for a copy.*

BROWN FINTUBE

**BROWN FINTUBE CO.**
*Elyria, Ohio*

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GRAVER

**CONSERVATION TANKS AVAILABLE**

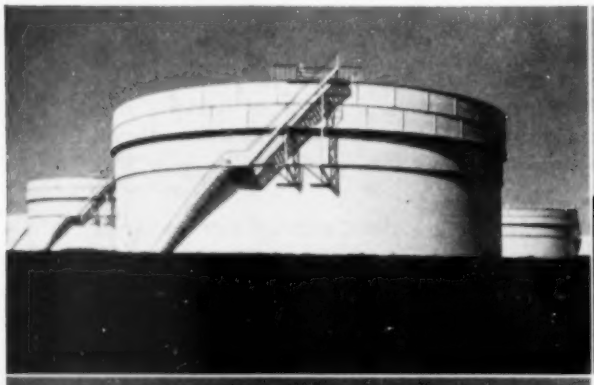
# Coast to Coast

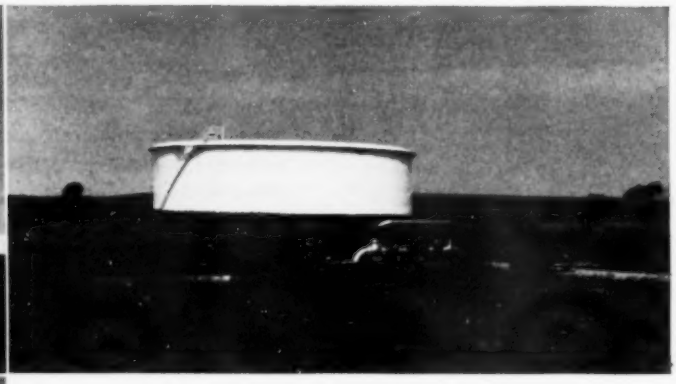
Graver has recently acquired additional facilities at Fontana, California, to serve as another important base for field erection of Graver Conservation Equipment. Now, throughout the country, Graver quality and service are almost literally "at your own back door."

There is a Graver conservation design to suit *your* exact needs. And Graver Engineering Representatives are as close as your telephone. Put our 97 years' experience to work for you!

***the* Graver Center-Weighted Floating Roof Tank** combines the economy of the pan-type roof with the stability of the double-deck floating roof. Built to principles of ship design, the roof is stable and will neither sink nor tilt. The entire deck is completely accessible for inspection.

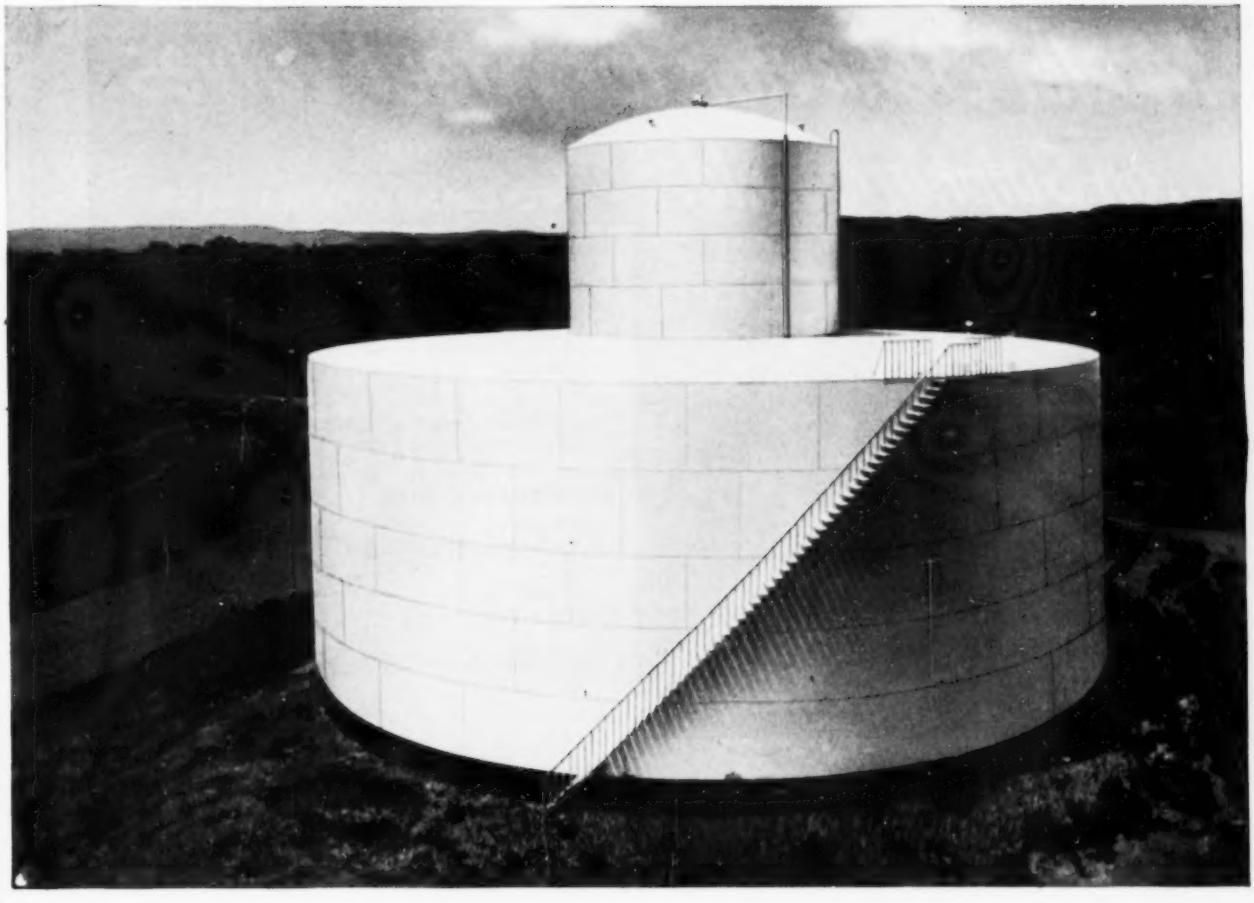
***the* Graver Expansion Roof Tank** eliminates breathing losses and minimizes filling losses. Its positive liquid seal, exclusive with Graver, protects under all conditions. Ideal for converting existing tankage, and simple to maintain, the Expansion Roof Tank may well protect an entire terminal.





***the* Graver Double-Deck Floating Roof Tank** floats directly on the liquid, preventing the formation of vapors. It is applicable alike to crude and product storage areas at refineries, pipeline terminals and large bulk installations.

GRAVER
CONSERVATION TANKS

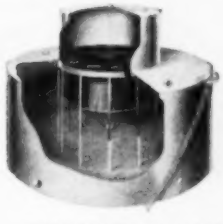


# the thrifty VAPOR-MIZER

This revolutionary conservation design warrants your attention! The Vapor-Mizer not only uses less steel in building, but requires smaller, less expensive vapor lines in manifolded tankage.

With the Vapor-Mizer, standing losses are eliminated and filling losses are very much reduced...in addition, the fresh quality of your product is maintained.

The Vapor-Mizer is readily adaptable to converting existing tankage into fully effective conservation units. And since it operates at very low pressures (less than one ounce), the reinforcement of manifolded tanks becomes unnecessary. Look into the many economies offered by the Vapor-Mizer!



**THE VAPOR-MIZER**

- **Eliminates standing losses... minimizes filling losses**
- **Requires less steel to build**
- **Readily converts older, existing tankage**

## GRAVER TANK & MFG. CO., INC.

**East Chicago, Indiana**

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# Model Behavior for Steel Valves

## ...on Sulphuric Acid, for instance

At a leading Gulf Coast lube oil plant, using Crane steel valves on lines to concentrated sulphuric acid storage and blow cases.

### VALVE SERVICE RATINGS

**SUITABILITY:** Giving full satisfaction

**FEATURES:** Compact bolted-bonnet design

**MAINTENANCE COST:** Routine service only needed

**SERVICE LIFE:** In lines more than 2 years

**OPERATING RESULTS:** Safe control of acid – no loss

**AVAILABILITY:** Catalog item – No. 3607X

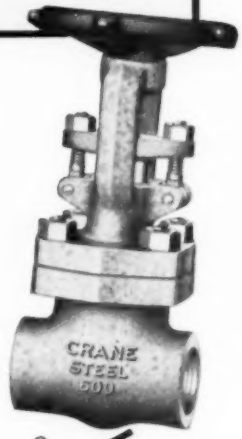
### THE CASE HISTORY

Valves formerly used in this service showed severe corrosion a few months after installation. Both stems and seats were affected, with early leakage resulting. Longest life of any of these valves was less than one year.

Replacement was made more than 2 years ago with Crane No. 3607X steel gate valves. By effectively sealing against atmospheric condensation, the deeper Crane stuffing box prevented dilution of acid and resultant stem corrosion. Wider seating surfaces give Crane valves higher resistance to seat corrosion and leakage. They're still in service; show no loss of efficiency. That's the result of thrifty buying—when quality is the first consideration.

### THE VALVE

You'll find big valve features in these Crane 600-pound bolted bonnet, small steel gates. They fill every need for quality, compact design, maximum strength with no excess weight. Easy to use; easy to service. Sizes, ½ to 2 in.; screwed, flanged, or socket-welding ends. See your Crane catalog or your Crane Representative.

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**VALVES • FITTINGS • PIPE • PLUMBING • HEATING**

# Tenamene 1
# Tenamene 2

## most effective gum inhibitors known

Tenamene gum inhibitors have set the standards of the industry for over 15 years. No known inhibitors are more effective in preventing gum formation.

They're economical too. For example, as little as 5 pounds of Tenamene 1 may be needed to treat 1000 barrels of gasoline—at a cost of approximately 2½¢ per barrel.

The use of Tenamene 2 results in an extra dividend for refiners. It can be used as a combination sweetening and inhibiting agent to save time, materials and equipment.

Send for the Tenamene booklets listed in the coupon. They contain interesting general information about gum inhibiting and sweetening as well as specific data about the Tenamenes. Our Petroleum Chemicals Laboratory will be glad to make tests and recommendations on any of your inhibiting or sweetening problems.

**SALES REPRESENTATIVES: Eastman Chemical Products, Inc.,** Kingsport, Tennessee; New York—260 Madison Ave.; Framingham, Mass.—7 Hollis St.; Cleveland—Terminal Tower Bldg.; Chicago—360 N. Michigan Ave.; St. Louis—Continental Bldg.; Houston—412 Main St. **WEST COAST: Wilson Meyer Co.,** San Francisco—333 Montgomery St.; Los Angeles—4800 District Blvd.; Portland—520 S. W. Sixth Ave; Seattle—821 Second Ave.

**Tenamene** EASTMAN GASOLINE ADDITIVES

**Eastman**
CHEMICAL PRODUCTS, INC.

**Eastman Chemical Products, Inc., Chemical Sales Division, Kingsport, Tenn.**

**Gentlemen:** Send me copies of your booklets: "Inhibiting Motor Fuels with the Tenamenes" and "Tenamene 2 Inhibitor Sweetening."

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COMPANY .....

STREET .....

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Sales Representative for **TENNESSEE EASTMAN COMPANY,** Kingsport, Tennessee, division of **EASTMAN KODAK COMPANY.**

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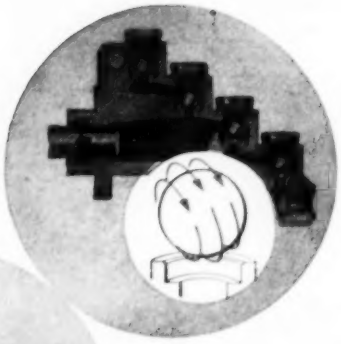
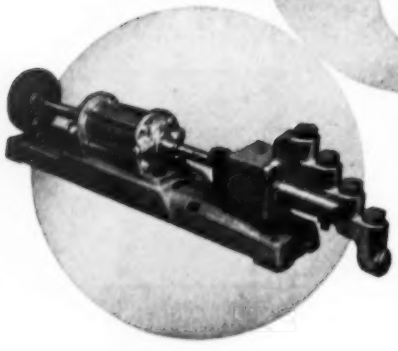


Basic design simplicity of the *exclusive* Milton Roy liquid end step-valve assures high and reproducible volumetric efficiency. Self-cleaning *double* ball-checks spin any lodged particle free, are non-clogging, seat positively.



# *One-Half of One Per Cent Accuracy with this Milton Roy Pump*

CONTROLLED VOLUME PUMPING

INSTRUMENTATION

PROCESS CONTROL SYSTEMS

BLENDING AND FORMULATING

ON THE JOB in a leading processing plant, two of these air-powered controlled volume pumps meter deionized water solution from a chemical proportioning system to a key production process. Data obtained from *one full year* of operation showed a pumping accuracy within ½ of one per cent!

This is a typical Milton Roy Pump—one of many types of air-powered or motor-driven positive displacement pumps—in daily use in hundreds of similar operations. In *chemical processing*, for example, they're used in fermentation, pH control, hydrogenation of fatty acids. In the *textile and paper fields*, for resin impregnations, peroxide saturates, finish liquors. In *metals and mining*, for plating solution recovery, ore flotation, diatomaceous earth slurry handling. Wide as industry itself, the application of these pumps gives dollar savings not only in accuracy, but in longer service life and man-hours saved. These pumps meter practically any liquid in capacities from 3 milliliters per *hour* to 45 gallons per *minute* against pressures ranging to 25,000 pounds per square inch. They are available as single or multiple units, or as component parts of complete chemical feed and control systems.

*Bulletin No. 351* gives you facts on Milton Roy **Air-Powered Controlled Volume Pumps** and their application. Write, **now**, for your **free** copy.

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***Engineering Representatives in the United States, Canada, Mexico, Europe, Asia, South America and Africa.***

# The Greatest Gasoline Development in 31 Years

**TCP*, a Shell discovered additive now blended into Shell Premium Gasoline, sets the pace for the fuels of tomorrow. It's another milestone in Shell's petroleum research.**

The long-recognized problem of power loss due to combustion by-products has been solved by Shell research. No longer need these by-products cause the waste of fuel and power associated with missing spark plugs and with pre-ignition.

Shell research has discovered and developed a fuel additive now in Shell Premium Gasoline—called TCP. This additive actually changes the character of harmful deposits *within the engine* so that faulty spark plug operation and pre-ignition are eliminated promptly—often during the second tankful. Old *and* new engines benefit alike.

Shell TCP additive was originally developed for aviation fuels. Up until now it has been restricted to military planes. Without question it is the greatest fuel development since the introduction of tetraethyl lead in 1922.

Important as TCP additive is for cars today, perhaps the greatest significance is its great promise for the future. TCP additive points the way to lighter, more powerful engines—engines with much greater design efficiency than has heretofore been possible.

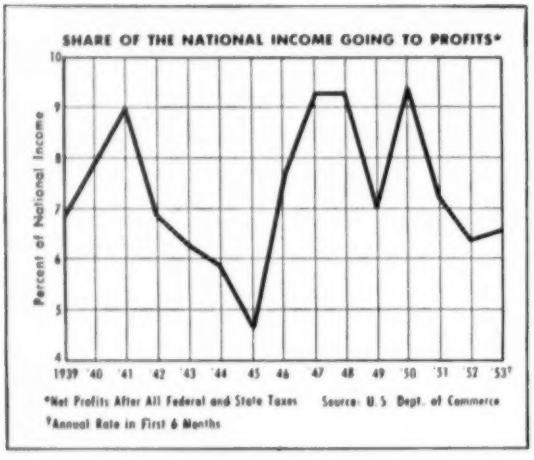
**TCP is Shell's trademark for this additive. It is another example of the progressive research that goes forward day and night in Shell laboratories. It is evidence again that Shell research provides more and better products from petroleum.**

*Patent applied for

**SHELL OIL COMPANY**

*The first of two articles on profits*

# PROFITS...How High Are They?


SHARE OF THE NATIONAL INCOME GOING TO PROFITS*
Percent of National Income
10
9
8
7
6
5
4
1939 '40 '41 '42 '43 '44 '45 '46 '47 '48 '49 '50 '51 '52 '53†
*Net Profits After All Federal and State Taxes
Source: U.S. Dept. of Commerce
†Annual Rate in First 6 Months

How high are profits? What is being done with them? This is the first of two articles designed solely to throw some factual light on these key economic questions.

One of the important economic developments of 1953 has been a substantial increase in the dollar volume of corporation profits from the level of 1952. But to answer the question "How high are profits?" we must also measure them: 1) by comparison with the record of previous years, and 2) as a share of the total national income. The term "profits," as used here, refers to profits *after taxes*. These are the only profits that can be paid to stockholders or retained for use in the business.

In the first six months of 1953, corporate profits *after taxes* were at an annual rate of $20.4 billion. This was higher than in the first half of 1952, but lower than in the full years 1948 or 1950, or in the first half of 1951. If allowance is made for the declining value of the dollar, this year's net profits for all corporations represent less purchasing power than those made five or six years ago.

Here is the record of profits over the years:

| | Net Profits After Taxes of All U. S. Corporations | |
|---|---|---|
| | Billions of Dollars | |
| | Actual | In 1953 Prices |
| 1929 | 8.4 | 14.6 |
| 1939 | 5.0 | 9.8 |
| 1947 | 18.5 | 22.1 |
| 1948 | 20.7 | 22.7 |
| 1949 | 16.3 | 18.3 |
| 1950 | 22.7 | 24.6 |
| 1951 | 20.1 | 19.7 |
| 1952 | 18.6 | 18.7 |
| 1953* | 20.4 | 20.4 |

*Annual rate, first six months

The record shows that real profits have a little more than doubled since 1939. This increase, however, does not mean that corporations are doing exceptionally well. The entire national income has doubled since 1939. And our industrial plant is more than twice as large as it was in 1939. Therefore, profits have just about kept pace with industrial growth.

### Return on Investment

How high are profits compared with sales, or compared with the stockholders' investment?

What is the rate of return to the people who have invested their savings in corporate business?

The table below shows that for the past three years the rate of return on both sales and investment has been substantially below the return achieved in earlier postwar years. The rate of return on stockholders' investment is higher now than it was in 1939. But this is primarily because today's profits are reported in terms of today's prices, whereas much of the investment in plant facilities is still carried on the books at prewar prices, which are substantially below the cost of replacement. The current rate of return, measured as a percentage of total corporate sales, is below prewar levels.

| | Corporate Profits After Taxes | |
|---|---|---|
| | Per Cent of Total Sales | Per Cent of Stockholders' Equity * |
| 1929 | 6.1 | NA |
| 1939 | 4.1 | 4.0 |
| 1947 | 5.3 | |
| 1948 | 5.3 | 14.8% average |
| 1949 | 4.4 | |
| 1950 | 5.3 | |
| 1951 | 4.1 | 11.8 |
| 1952 | 3.6 | 10.3 |
| 1953# | 3.7 | 10.8 |

* Manufacturing corporations only
NA Not available
# Annual rate, first six months

In considering these figures, it should be remembered that they are averages for all corporations. Some companies make more than the average, and many make no profit at all. In every year since 1915 at least 25% of all corporations have operated at a loss. In 1939, 58% of all corporations were losing money. This year the figure will probably be at least 30%. The improvement since 1939 shows a much healthier economy. But it does not indicate that profits are easy to make.

### How Big a Share of the Pie?

The most important single fact about profits is that they now represent a *smaller* share of national income than they have in past years of normal prosperity. For the past three years, profits have taken a smaller share of the pie than in 1939, and considerably smaller than in the early postwar years. Here, as the chart at the beginning shows, is the record:

| | Corporate Profits After Taxes as a Percentage of National Income |
|---|---|
| 1929 | 9.6 |
| 1939 | 6.9 |
| 1947 | 9.3 |
| 1948 | 9.3 |
| 1949 | 7.5 |
| 1950 | 9.4 |
| 1951 | 7.2 |
| 1952 | 6.4 |
| 1953* | 6.6 |

*Annual rate, first six months

The main reason for the declining corporate share of national income is, of course, the increasing share taken by the federal government in the form of taxes. The wage earners' share is also higher than in 1939. But the really startling increase is in federal taxes. Taxes on profits now equal almost 8% of the national income, compared to only 2% in 1939.

### Why This Is Important

It is important that these facts about profits and taxes be widely understood. At its next session, Congress must consider what to do about the emergency taxes on profits enacted after the outbreak of the Korean War. The so-called excess profits tax is scheduled to die on January 1, 1954. In the absence of new legislation, the rate of the corporate income tax will drop from 52% to 47% on April 1. Many factors, including the revenue needs of the government, must enter into the decision whether or not to reduce taxes. But one fact stands out clearly: By comparison either with past years or with the total national income, corporate profits today are relatively low.

* * *

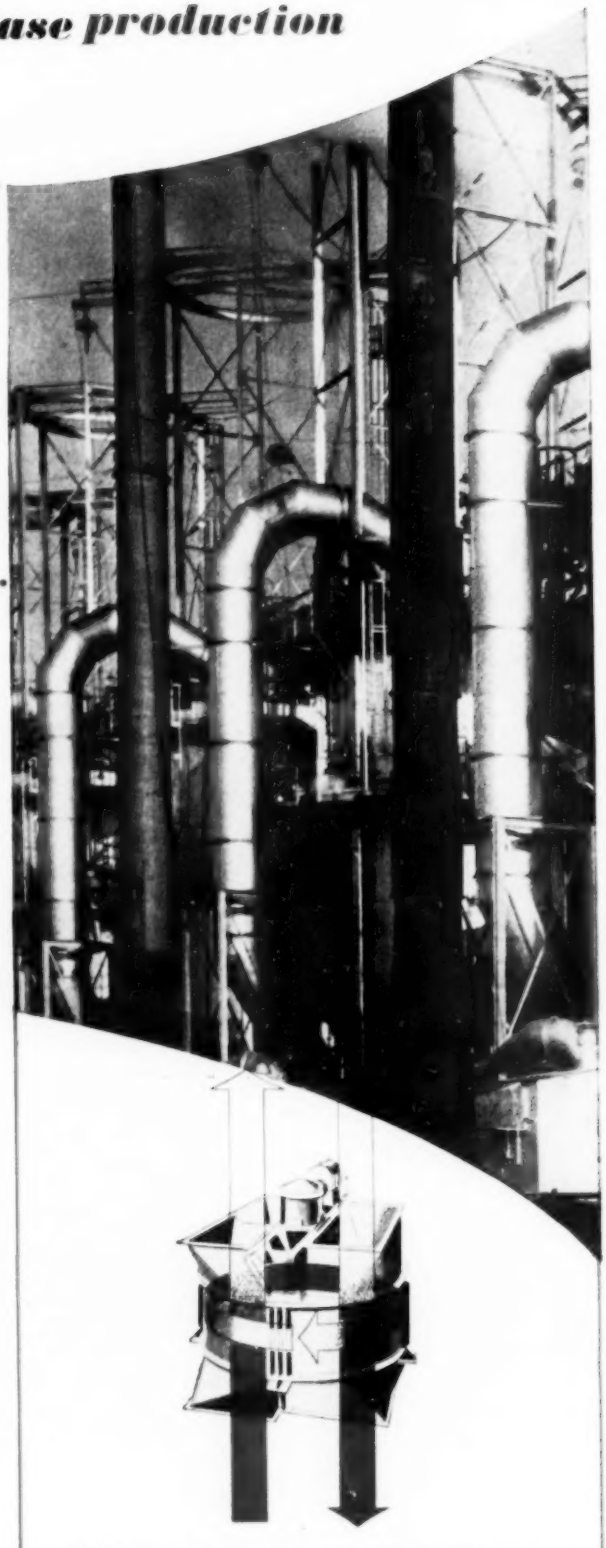
*The second article in this series will discuss what corporations do with their profits.*

**McGraw-Hill Publishing Company, Inc.**

## *Reduce slag ...increase production*

*with the*

# Ljungstrom Air Preheater



**Slag** – primary cause of reduced capacity – can be practically eliminated by the use of a Ljungstrom Air Preheater.

That's because preheated air mixes more thoroughly with the fuel. Therefore, less excess air is required for complete combustion – and less combustible material is lost in the flue gases.

Thus, with a Ljungstrom Air Preheater, there is less material present in the furnace for slag production. Oil tubes stay cleaner . . . longer. Stills stay on stream *at top production* for months longer.

For example, a pipe still in an eastern refinery dropped from 16,000 barrels a day to 12,000 because of slag. Now, with a Ljungstrom Air Preheater and modern high-temperature burners, the still operates *continuously at 18,000/20,000 barrels.*

**This saving alone** can pay for a Ljungstrom installation in less than a year. Add it to more economical furnace design possible . . . up to 20% fuel savings . . . greater heat recovery even from low grade fuels . . . higher through-put – and you can see why the Ljungstrom Air Preheater is perhaps *the most significant guidepost to economy available today to refiners.*

For more complete details on what the Ljungstrom Air Preheater can do for you . . . for an analysis of the heat recovery benefits attainable in your fuel burning equipment – call or write The Air Preheater Corporation today.



The Ljungstrom operates on the continuous regenerative counter-flow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.

**The Air Preheater Corporation**

**60 East 42nd Street . New York 17, N. Y.**

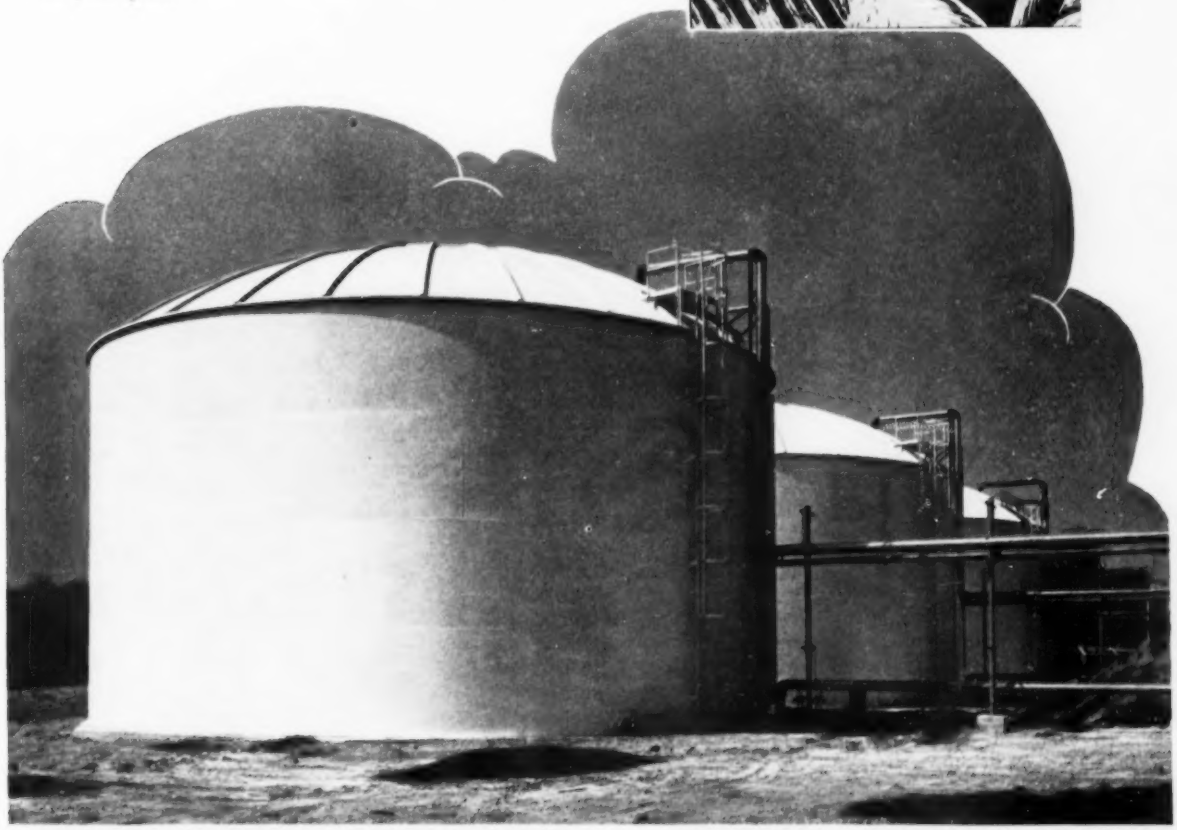
***WHEREVER YOU BURN FUEL, YOU NEED LJUNGSTROM***

# C B & I FIELD WELDING SUPERVISION SERVICE

## *to build a better tank at no extra cost to you*

Every Horton welded structure built has a Field Welding Supervisor assigned to inspect it . . . at *no extra cost* to you! It is the Supervisor's job to assist the Foreman and his crew to build a better tank. He checks every aspect of the welding and helps magnaflux, x-ray or stress-relieve joints when called for by specifications. He supervises the cutting and grading of the required number of test plugs and helps train and qualify new men when additional welders are needed.

When planning a stainless steel clad tank like that shown below, a Hortonsphere, a Hortonspheroid . . . or any other welded steel plate structure, write our nearest office for information, estimates or quotations. There is no obligation on your part.



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| Boston 10 | 1029-201 Devonshire Street | Houston 2 | 2130 C & I Life Building | San Francisco 4 | 1559-200 Bush Street |
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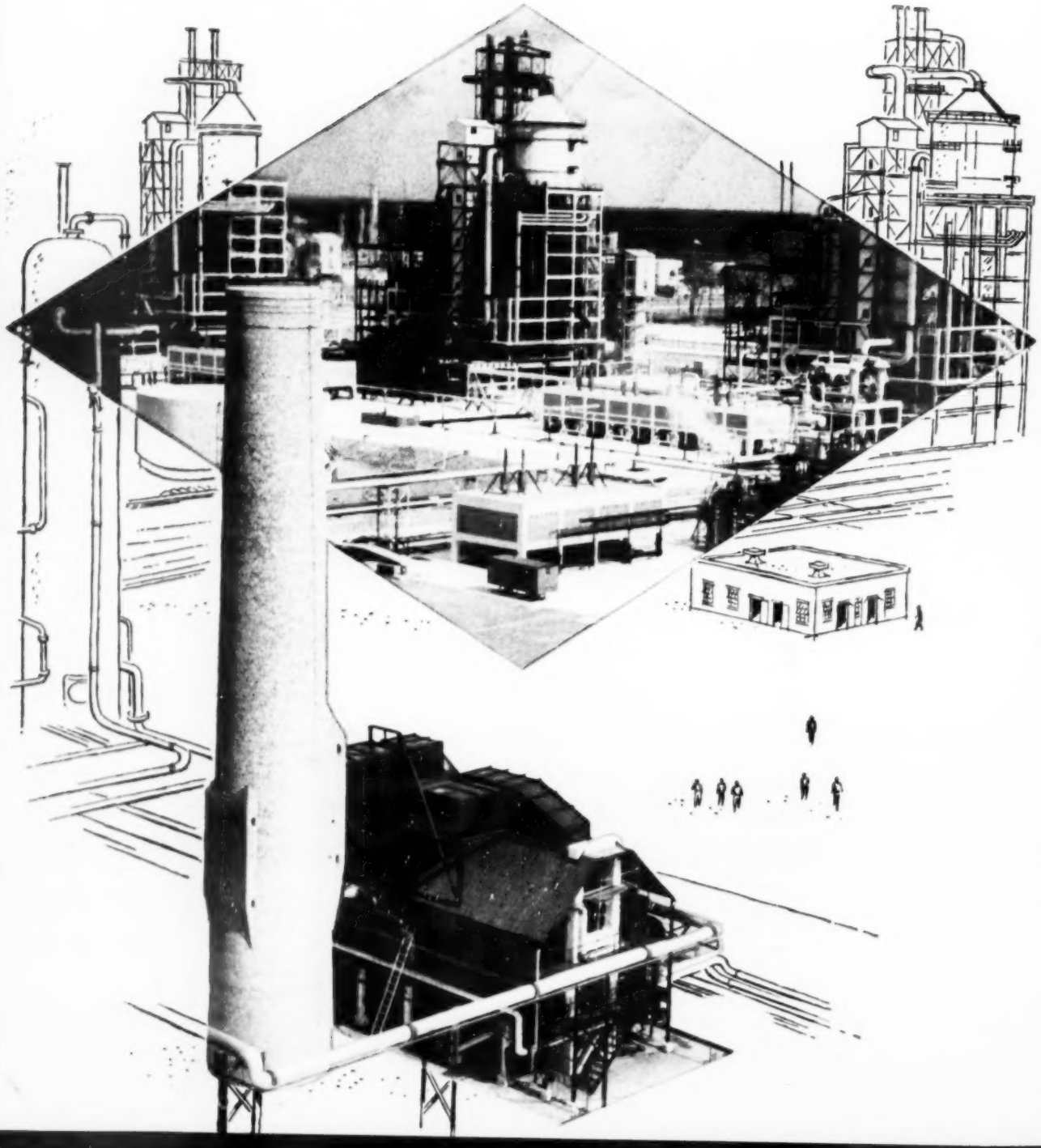

# FOR CAT CRACKING

## oil industry favorites!

It's the *catalyst* that speeds the cracking—but it's the *castable* that protects the vessels and makes possible today's ever-more-efficient petroleum products.

Such *quality* castables as Grefco's famous LITECAST, and LITECAST-50 against the shells in so many American crackers . . . and Grefco's High Strength BRIK-CAST to form the tough duty inner sections.

High Strength BRIK-CAST provides exceptional resistance to abrasion, ease of application, extremely low rebound loss. Couple it with LITECAST and you add insulation that means production economy and efficiency.

All through refineries, from coast to coast, you will find these and other Grefco products. Products which offer easy air placement, low thermal conductivity—and application by trowelling where cement gun application is impossible without a change in mix.

Sixty-six Grefco mines and plants—together with hundreds of dealers and warehouses—are at your service. Wherever you may be, you can depend upon quality castables to be on your job quick! Grefco prides itself that it offers all industry strategic sources of supply for dependable and continuous operation.

**GENERAL REFRACTORIES COMPANY**
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GENERAL REFRACTORIES

**RINGS.** *Sizes:* From 3/32" I.D. x 3/16" long x 7/32" O.D. to ½" I.D. x 1" long x 1" O.D.

**PELLETS.** *Sizes:* From ⅛" x ⅛" to ½" x ½".

**SPHERES.** *Diameters:* ¼" to 1".

# Rx for shorter contact time!

***Norton specially engineered carriers bring proved advantages to a wide range of processes***

Whatever your specific application may be, it will pay you to investigate the many advantages of Norton catalyst carriers.

Made of ALUNDUM* (fused alpha alumina), these highly refractory carriers are outstanding for heat conductivity, chemical inertness, mechanical strength and abrasion-resistance. And Norton's exclusive *controlled structure* process offers you a choice of porosities. In pellets and rings, porosities range from medium to high. In spheres, porosities range from medium, with rough exterior for coating with catalyst... to high, with a network of open pores and rough exterior for impregnating with catalyst.

Chemical engineers are finding this Norton "Special Refractory Prescription" invaluable in processing many different products. For example, in meeting the rapidly growing demand for phthalic anhydride, Norton catalyst carriers aid in shortening catalyst contact time and in achieving the highly exothermic reaction in fixed bed converters.

***Test Them Out***

Find out just what Norton ALUNDUM catalyst carriers can do for you. See your Norton Representative for samples, or write to NORTON COMPANY, 270 New Bond Street, Worcester 6, Mass.

*Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.

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*Making better products... to make other products better*

**NORTON COMPANY, WORCESTER 6, MASSACHUSETTS**

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## Ratographic* MINIATURE RECORDER

## *Handles 4 separate signals*

Wider application of miniature instrumentation to your own needs is now possible with the new Fischer & Porter Ratographic miniature recorder. Fitting a panel area only six inches square, the instrument *records* two variables and *indicates* two variables—OR—*records* three variables and *indicates* a fourth. It combines the same dependability, stability and accuracy which characterize *all* Fischer & Porter instruments, large and small. Check the many advantages of this instrument as listed here, then write for further information. Fischer & Porter is always ready to supply engineering assistance on *your complete process instrumentation.*

**for recording...**

- four simple and dependable capsule receivers
- 4" *rectilinear* chart, air or electric drive
- outside dimension 6" square
- convenient daily chart tears off without chart waste

**for controlling...** with **F&P** point of measurement controller mounted as illustrated, unit offers:

- record of both uncontrolled and controlled variables, with indication of valve and set point signals.
- large, easy to adjust external transfer valve and set point knobs

Glass door: no warping, scratching, or crazing. Recording, indicating and controlling functions continue to operate when chassis is extended from front of panel.

*complete process instrumentation*

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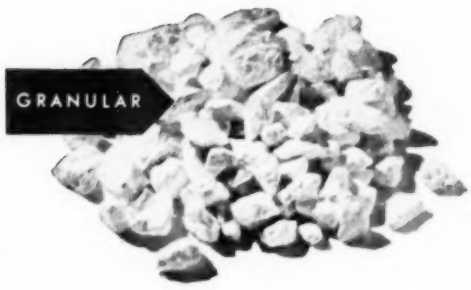
*T.M., F&P Co.

2262




HARSHAW

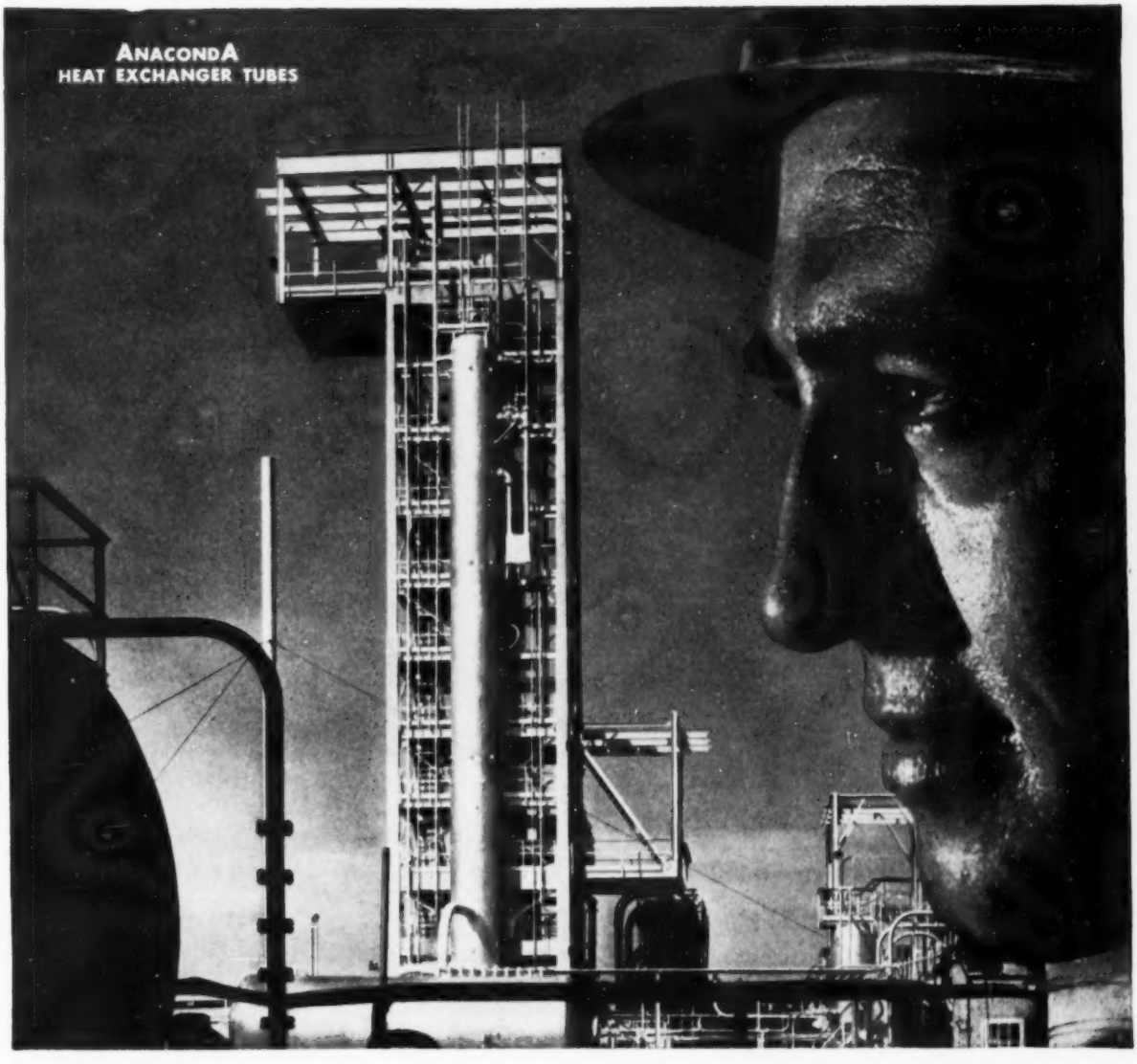
# you specify the catalyst

## HARSHAW can make it!

● Harshaw has a large production capacity for preformed catalysts. In many cases economies can be realized by having Harshaw manufacture catalysts to specification for Hydroforming . . . Cyclization . . . Oxidation . . . Dehydrogenation . . . Hydrogenation . . . Dehydration . . . Desulphurization . . . Alkylation . . . Isomerization. Typical catalysts and catalytic chemicals are . . . Aluminum Chloride Anhydrous . . . Boron Fluoride Addition Compounds . . . Boron Trifluoride . . . Hydrofluoric Acid Anhydrous . . . Activated Alumina . . . Chrome Alumina . . . Molybdena Alumina . . . Tungsten Alumina . . . Cobalt . . . Copper . . . Copper Chromite . . . Magnesia . . . Nickel . . . Vanadium.

Our experienced technical staff will assist you in developing the best and most economical catalyst. If you have a catalytic process in the development or production stage, a discussion with us may prove beneficial.

**THE HARSHAW CHEMICAL CO.**
1945 East 97th Street, Cleveland 6, Ohio
*BRANCHES IN PRINCIPAL CITIES*




# ARSENICAL ADMIRALTY-439:

## OIL REFINER'S FAVORITE

WHERE oil refinery products handled by heat exchangers and condensers present no unusual problems of corrosion, high temperatures or high cooling water velocities, long experience indicates that tubes of Arsenical Admiralty-439 are the logical choice for satisfactory service life at economical cost.

This ANACONDA Tube Alloy offers good resistance to gas streams from both sweet and sour crudes and satisfactorily resists gases from sour crudes containing neutralizers. In addition, it is highly resistant to dezincification and, thus, can handle corrosive cooling waters at relatively high temperatures—a property which makes it definitely superior to non-arsenical Admiralty in most applications.

Whatever alloy best fits your operating conditions, choose it from the extensive line of ANACONDA Alloys for tubes and plate sheets. Our Technical Department's long experience in analyzing tube-performance problems is freely available to you. We have been working with copper and copper alloys for more than a century. 5313

**for efficient heat transfer**

**ANACONDA®**
**Heat Exchanger Tubes**

**The American Brass Company, Waterbury 20, Conn.**
**(In Canada: Anaconda American Brass, Ltd., New Toronto, Ontario)**
Send me Publication B-2 "Anaconda Tubes and Plates for Condensers and Heat Exchangers"

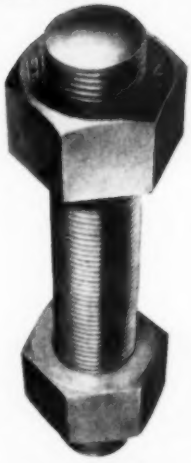
NAME .....
COMPANY .....
STREET .....
CITY ..... ZONE ..... STATE .....

 (*To obtain more data on advertised products see page* 1760)

# Economy Where It Counts

Put this fastener team to work in bolting applications where temperatures and pressures run high, and you can count on economical service, with a minimum of down-time.

The Bethlehem Continuous-Thread Stud, used with two Bethlehem Quenched Nuts, makes an economical combination for high-temperature, high-pressure bolting, because of the way it resists premature fatigue failure.



***Bethlehem Continuous-Thread Stud***

The Bethlehem Continuous-Thread Stud gives long service because it minimizes stress-concentrations. There being no point of thread-runout on the stud, stresses cannot converge at any one point to cause premature failure. Instead, they are well distributed along the working length of the stud. The stud, made from carbon or alloy steels, is furnished either plain or heat-treated.

***Bethlehem Quenched Nut***

The Bethlehem Quenched Nut is made from 0.40 to 0.50 carbon steel by a process of forging and extruding hot steel in a forming die. It is then quenched and tempered, providing the nut with sufficient strength to develop the full strength of *any* stud or bolt with which it may be used.

The Continuous-Thread Stud and the Quenched Nut come in a full range of sizes. A letter or phone call to the nearest Bethlehem office will bring you full information.

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
*Export Distributor:* Bethlehem Steel Export Corporation

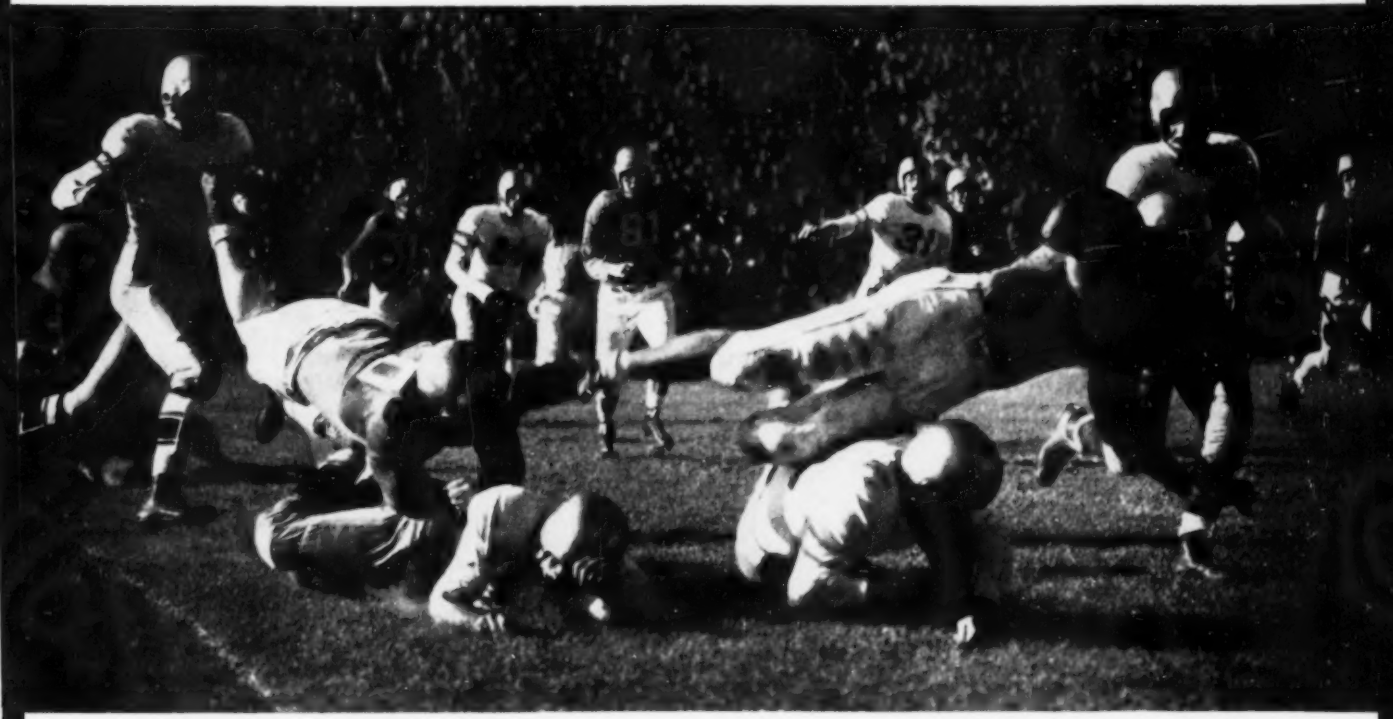
*Bethlehem supplies every type of Fastener*

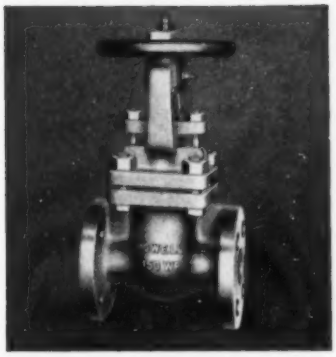
# STAR PERFORMERS

From coast to coast, Powell Valves have won enthusiastic approval. For *every* Powell Valve is a *star for outstanding performance*. They have a record of dependability since 1846.

Small wonder that Powell Valves have made such a hit through the years. Powell has probably done more valve research, solved more valve problems and makes more types of valves than any other organization in the world.

We're sure that *you* will be enthusiastic about Powell Valves too once you see how they perform. Following are just a few members of the Powell all-star cast of valves which are available through distributors in principal cities. If a distributor is not located near you, just write us. We'll be pleased to tell you more about these valves—and our complete line.

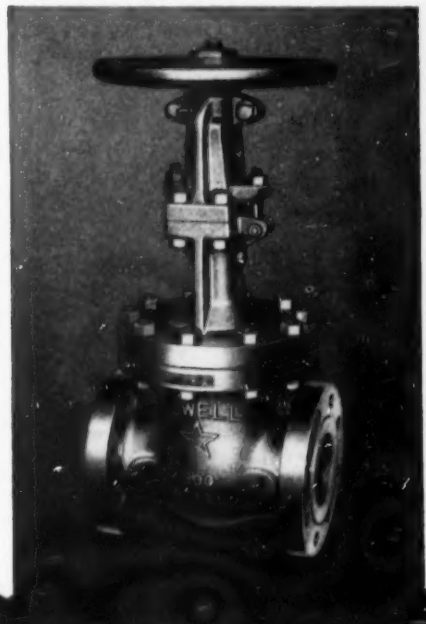




**O.S. & Y. GATE VALVE** *(Fig. 2491)* for 150 pounds W.P. at 500 F. Stem is threaded and guided through a revolving bushing in upper yoke. Sizes ¼" to 2", inclusive.

**BRONZE "WHITE STAR" GATE VALVE** *(Fig. 375)* for 200 pounds W.S.P. Union bonnet with inside screw rising stem. Renewable "Powellium" Nickel-Bronze wedge.

**CAST STEEL GATE VALVE** *(Fig. 3003)* for 300 pounds W.S.P. Bolted flanged bonnet with outside screw, rising stem and yoke. Sizes 1" to 24", inclusive.



**CAST STEEL SWING CHECK VALVE** *(Fig. 1561)* for 150 pounds W.S.P. Bolted flanged cap. Heavy rugged construction. Available in sizes ¾" to 18", inclusive.

P V

# Distiller saves 4 ways

**THE PROBLEM:**

To find a pump capable of handling an extremely viscous, corrosive syrup to the fourth stage of a multiple-effect evaporator. The pump not only had to resist corrosion but abrasion as well — since the syrup contained up to 35% solids.

**THE SOLUTION:**

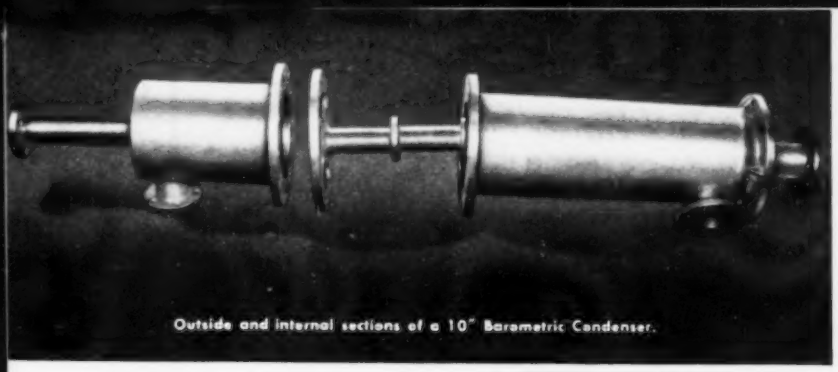
The installation of a compact, low-capital-investment Ampco Centrifugal Pump — the pump made of durable Ampco Aluminum Bronze Alloys that resist abrasion, corrosion, and cavitation-erosion — a special pump at a standard-pump price.

**THE RESULTS:**

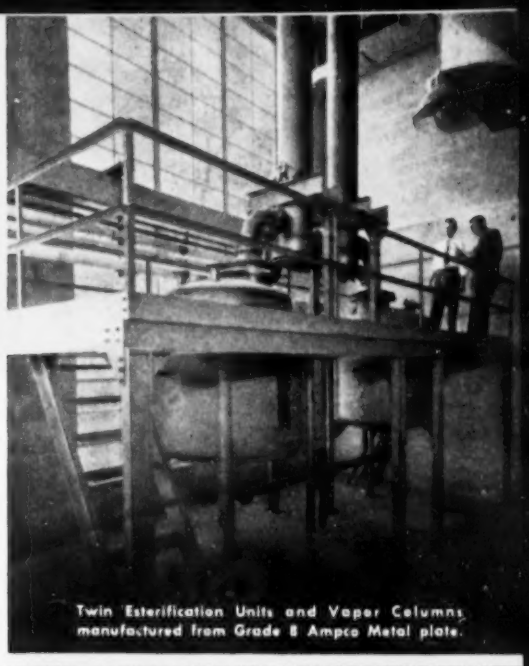
More than a year of day-in, day-out service proved the dependability and efficiency of Ampco Centrifugal Pumps.

The corrosion problem is solved. The pump shows practically no signs of wear —despite the high percentage of abrasive solids it handles. Power costs are ⅔ less. Space savings are tremendous. And process efficiency is improved — shutdowns are infrequent, minimum cleaning is required, because the pump maintains a constant liquid level in the evaporator tubes.

Ampco Centrifugal Pump installed in Foods and Feeds Department, Joseph E. Seagram & Sons, Inc. Distillery, Lawrenceburg, Indiana.



Outside and internal sections of a 10" Barometric Condenser.



Twin Esterification Units and Vapor Columns manufactured from Grade 8 Ampco Metal plate.

1. Uses 66% less power
2. Cuts space requirements
3. Improves process efficiency
4. Eliminates weekly pump maintenance

## . . . with Ampco Centrifugal Pump made of

# AMPCO* BRONZES

## — resistant to abrasion, corrosion and cavitation-erosion

Ampco engineered aluminum bronze alloys have high resistance to corrosion, erosion and abrasion.

That's why you find them used in both the process industries and marine service — used for tanks, pipe, fractionating towers, bubble caps, separators, condenser water boxes, agitators, stills, etc.—wherever there's a need for high resistance to these thieves of production time and money.

That's why Ampco Centrifugal Pumps save you money when the going is tough. They're the pumps made from Ampco — the pumps that resist the destructive action of corrosion, abrasion and cavitation-erosion.

Ampco aluminum bronzes make good where other metals fail. Perhaps they can help you. They're available in a wide variety of forms — sheet, plate, extrusions, pipe, tubes, fasteners, etc. They can be easily fabricated with Ampco-Trode* electrodes. Consult your nearest Ampco Field Engineer or write us for further information.

Sulfuric acid sludge tank, made of Grade 8 Ampco Metal plate under construction at large Pacific Coast Refinery.

*Tear out this coupon and mail today!*

*Reg. U. S. Pat. Off. Ampco Metal, Inc.

**Ampco Metal, Inc.**

MILWAUKEE 46, WISCONSIN

*West Coast Plant* —

BURBANK, CALIFORNIA

AMPCO METAL, INC., Dept. CE-10, Milwaukee 46, Wis.

☐ Yes, I'm interested in Ampco Centrifugal Pumps. Send me literature.

☐ Send me information on the application of Ampco Aluminum Bronzes for corrosion-resistant service in the Process Industries.

Name ..... Title .....

Company Name .....

Company Address .....

City ..... ( ..... ) State .....

PP-11

# FACTS ON INFRARED FOR THE PROCESS PLANT

## *Do You Have Process Stream Problems?*

Through the use of infrared analyzers a continuous check can be maintained on process stream composition. Thus changes in feed stock, catalyst efficiency, reaction rate or final product composition become readily apparent.

Perkin-Elmer offers the most complete range of infrared instruments for both laboratory and plant use. Complete problem evaluation service is available without obligation. And Perkin-Elmer instruments are supplied sensitized and adjusted for your specific process stream application.

Why not make use of Perkin-Elmer's extensive application engineering facilities? They have been established to provide expert assistance in the application of infrared methods of analysis to specific processes.

Let us show you how your plant operating efficiency may be improved through infrared analysis. Our application engineering facilities are at your service.

*A battery of* TRI-NON *Analyzers undergoing sensitization for particular problems in Perkin-Elmer's Application Engineering Laboratory.*

THE ONLY COMPLETE RANGE OF INFRARED INSTRUMENTS TO MEET ALL REQUIREMENTS

**FOR THE PILOT PLANT—*Model 14 Multi-Component Analyzer*—** Continuously records the concentration of up to six components in a pilot process stream on a six-minute cycle. Ideal for tracking the effects of temperature, pressure, etc., changes in a pilot stream.

**FOR THE PROCESS PLANT—*Model 93 BICHROMATOR* Analyzer*** —For continuous control of liquid or gas streams. Records the ratio of any two wavelengths chosen. Thermostatted; enclosed in explosion-proof containers.

**FOR THE PROCESS PLANT—*Model 105 TRI-NON* Analyzer*** —Highly stable and sensitive. Suitable where there is considerable interference from stream components. Thermostatted; enclosed in explosion-proof containers.

*Trademark The Perkin-Elmer Corporation

Please send the bulletins checked

Model 14 ..... Models 93 and 105 .....

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TITLE .....

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**The Perkin-Elmer Corporation, 812 Main Avenue, Norwalk, Conn.**
**Southern Regional Office: New Orleans, Louisiana**

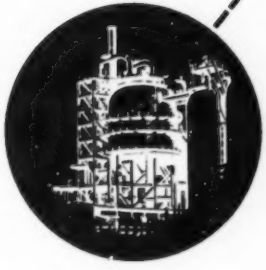
For Optical Design and Electro-Optical Instruments

PERKIN ELMER

# Nalcat® DELIVERS

## Cracking Catalyst Performance

## on the Dot



Nalcat FLUID CRACKING CATALYSTS

CATALYST DIVISION
NATIONAL ALUMINATE CORPORATION
4003 West 71st Street,
Chicago 29, Illinois

In the almost quarter century that we have been in business, we have been called upon to develop and produce many highly specialized types of expansion joints. None, however, have been more spectacular than the 109-inch joints recently developed for use in testing equipment for aircraft engine prototypes. These low pressure joints were designed with a hundred internal tie bars, which permit the joints to absorb the lateral deflection between a long exhaust header, operating at 650° F. and a series of large gas coolers, without the need for heavy anchors. Eight of these joints are now in service in a classified defense project.

This is just another example of how Zallea engineers, with the experience gained from specializing in one product—expansion joints, are able to successfully and economically solve the most difficult problems confronting this type of industry.

But this is not all—we regularly manufacture a complete line of expansion joints capable of service in virtually any type of expansion application. These joints are available in diameters from 3 inches to 30 feet for temperatures from sub-zero to 1600° F. . . . for pressures from vacuum to 300 psi in standard designs and up to 2,000 psi in special designs.

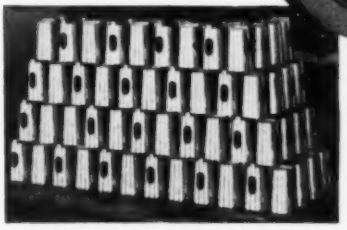
For full details regarding your expansion joint problems or requirements, just get in touch with us. Zallea Brothers, 822 Locust Street, Wilmington 99, Delaware.

*For detailed information on Zallea Expansion Joints and services write today for a free copy of Bulletin 351.*

Zallea
EXPANSION JOINTS

WORLD'S LARGEST MANUFACTURERS OF EXPANSION JOINTS

This Monel tube bundle used in an HF Alkylation Unit Dehydrator Reboiler is an excellent example of the use of Monel to resist corrosive chemical attack even at high operating temperatures.



These plugs for 2-inch plug valves used in hydrofluoric acid alkylation service were machined from Monel rod. No. 140 Monel Arc Electrodes are used for overlaying steel plugs in larger valves.

# How Monel muzzles HF ...even at high temperatures

Monel lined hydrofluoric acid regenerator column with 1/16" minimum lining of Monel. The two Monel grids are for holding the Raschig rings.

Anhydrous hydrogen fluoride and hydrofluoric acid are good and valuable servants. *But* they have to be controlled with a firm hand.

Allowed to have their own way, they'll chew right through most materials. Some materials resist the dry or highly concentrated acid but succumb to dilute solutions; other materials act in the reverse.

But it's a different story with Monel®!

Experience in hydrofluoric acid alkylation units has proven that Monel is usefully resistant to attack by aqueous HF in all concentrations at temperatures up to 250° F.—with anhydrous acid and steam-HF mixtures, Monel shows good resistance at temperatures as high as 1100° F.

Monel is comparatively insensitive to the effects of velocities which increase the corrosion rate of other materials. Therefore, it is suitable for valves, pumps and pipe lines, for impellers, stators and shafts, and for bubble caps and linings in hydrofluoric acid distillation columns.

It does not acquire a scale when exposed to anhydrous HF which makes it especially useful for moving parts having close clearances, such as plug valves and pump rings.

In addition to excellent chemical characteristics Monel provides its well-known physical properties . . . high strength . . . easy fabrication and welding.

It is advisable to place equipment orders with your supplier well in advance of scheduled use. Distributors of Inco Nickel Alloys can supply the latest information on availability from warehouse and mill.

And if you have a special metal selection problem, Inco's Corrosion Engineering Section will be glad to help. Write them today. Write also for your free copy of "Corrosion by Hydrofluoric Acid," reprinted from The Oil and Gas Journal.

**The International Nickel Company, Inc.**
67 Wall Street, New York 5, N. Y.

MONEL . . . *for minimum maintenance*

Combined trip-throttle valve permits operator to throttle steam directly into G-E Type DP Mechanical-Drive Turbine, usually eliminating need for extra valve in steam line.

## *ANOTHER PLUS VALUE OF G-E MECHANICAL-DRIVE TURBINES...*

# Combined Trip-throttle Valve Cuts Turbine Installation Costs

To save you the cost both of buying and installing a throttle valve in the steam line, General Electric designed into its standard Type DP mechanical-drive turbine a trip valve which also functions as a throttle valve. This feature alone can save you up to $200.00 at time of installation.

The combined trip-throttle valve controls steam admission to the turbine on starting and also shuts off all steam in case of overspeed. No need in most cases to shut off steam valves ahead of the turbine before restarting the unit. The combined trip-throttle valve can quickly be reset and the turbine put back on the line, saving you time in an emergency.

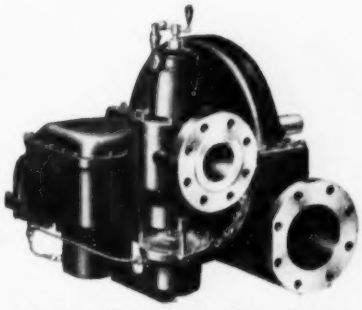
**THIS COMBINED TRIP-THROTTLE VALVE** is just one of many DP features which save you money. The chart below indicates other areas of savings.

Remember—the total cost is often more than just the sales price. But G.E.'s standard DP turbines include the extra features to save you extra costs. For more information contact your nearest G-E apparatus sales office. Write for bulletin GEA-4955A, "A New Standard in Mechanical-drive Turbines," General Electric Company, Schenectady 5, N. Y. 252-63

# GENERAL ELECTRIC

### INSTALLATION AND MAINTENANCE COST-SAVING FEATURES

| THESE EXTRA FEATURES, STANDARD ON ALL G-E TYPE DP TURBINES, CAN . . . | Save You up to |
|---|---|
| **COMBINED TRIP-THROTTLE VALVE** Eliminate extra cost of buying and installing valve ahead of the turbine. | $200.00 |
| **SINGLE RESERVOIR FOR COOLING LUBE OIL** Eliminate extra cost of piping cooling water to and between bearings. | 50.00 |
| **MAJORITY OF PARTS INTERCHANGEABLE** One set of spare parts protects several units—less money tied up in inventory. | 100.00 |
| **METALLIC-LABYRINTH VALVE STEM BUSHING** Eliminate labor costs of replacing soft packings; cut down-time production losses. | 50.00 |
| **SHAFT MONEL-SPRAYED AT PACKING FIT** Saves frequent cost of purchasing and installing carbon rings; contributes to long shaft and packing life. | 20.00 |
| **ESTIMATED TOTAL SAVINGS** | $420.00 |

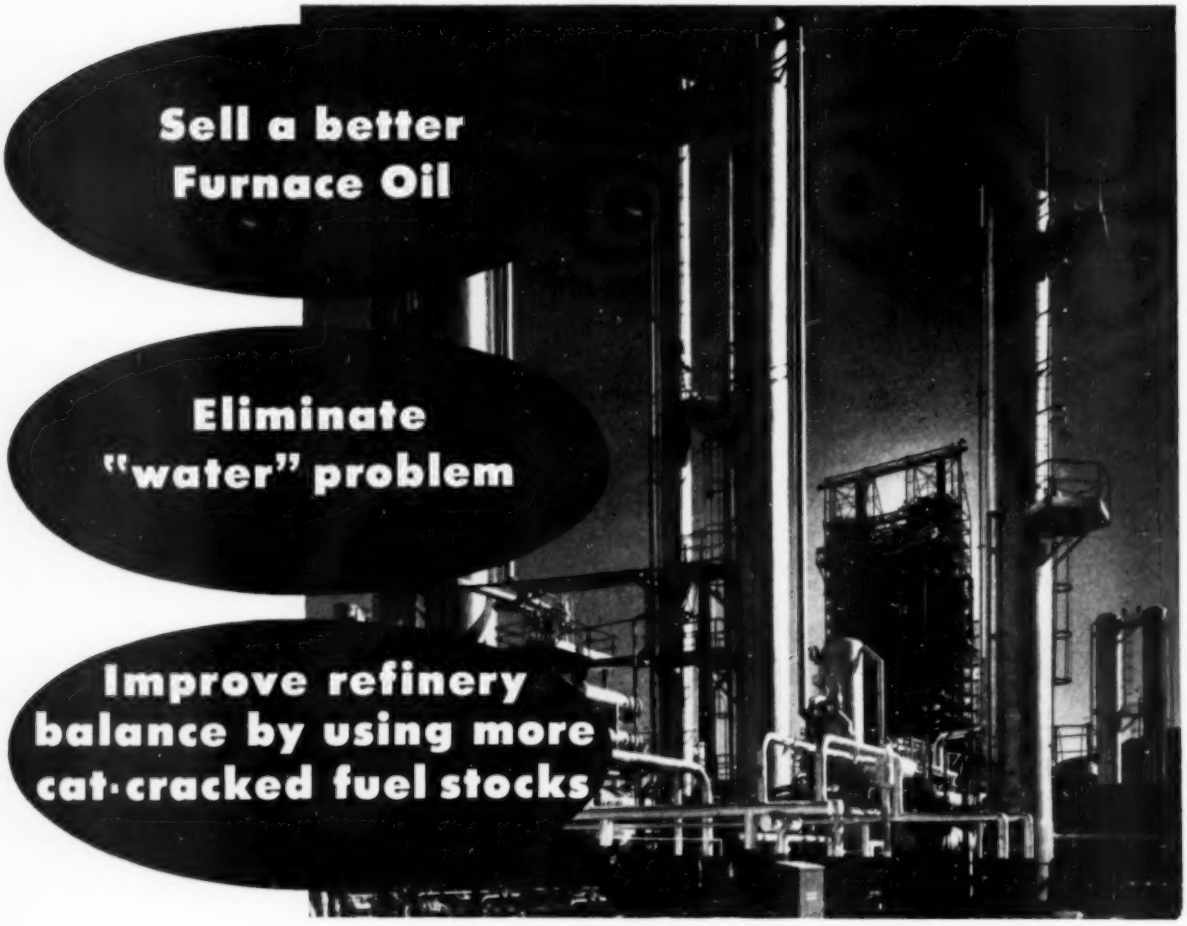


G-E Type DP Mechanical-Drive Turbine

*COMPARE THE FEATURES*
*EVALUATE ALL THE COSTS*

See why G-E standard Type DP turbines are your most economical buy.

# With NEW Dispersant FO




Dispersant FO is a new anti-gumming, rust-inhibiting additive that greatly reduces, even eliminates, deposits and screen clogging in home heating units and storage tanks. Your product with FO will offer dealers many competitive advantages and greatly reduce their number of costly service calls due to clogged filter screens and nozzles.

"Water" is always *the big problem* for the distributor, dealer and home user. The active ingredient in FO is an entirely new chemical, developed especially for use in furnace oils. NEW DISPERSANT FO DOES NOT EMULSIFY WATER WITH BURNER OIL. It will settle the water out of burner oils in short order to provide a "dry" fuel.

Furnace oil with FO has exceptional rust-proofing properties. Steel and iron surfaces in contact with the oil are made corrosion resistant.

This new additive improves stability and permits the blending of higher percentages of cat-cracked stocks without additional gum formation. It improves refinery balance, and you can cut costs by reducing the severity of acid treating of your cat-cracked heating stocks.

The stabilizing action and rust-inhibiting quality of Dispersant FO are obtained at very low dosages. Usually added in the ratio of 1 pint per 1000 gallons of oil stock, at any temperature, prior to shipment by tanker, pipe line or truck.

*For complete product data and samples, write or phone the nearest Oronite office.*

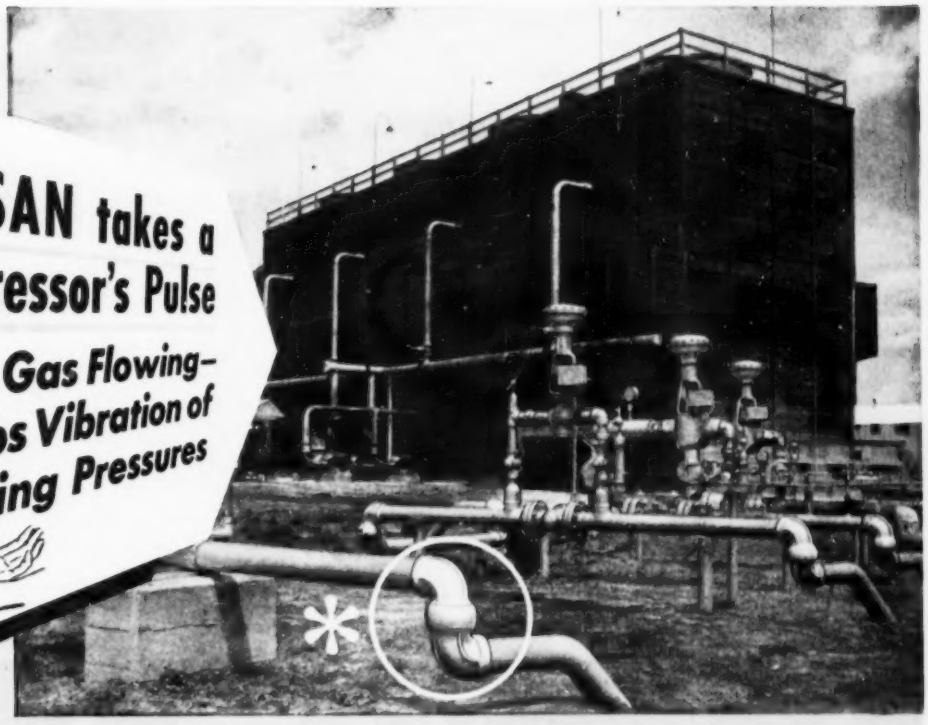
**ORONITE CHEMICAL COMPANY**

38 SANSOME STREET, SAN FRANCISCO 4, CALIFORNIA
30 ROCKEFELLER PLAZA, NEW YORK 20, NEW YORK
STANDARD OIL BLDG., LOS ANGELES 15, CALIFORNIA
600 S. MICHIGAN AVENUE, CHICAGO 5, ILLINOIS
MERCANTILE SECURITIES BUILDING, DALLAS 1, TEXAS

ORONITE CHEMICAL COMPANY
THE NAME TO WATCH IN CHEMICALS

# CHIKSAN takes a Compressor's Pulse

## Keeps Gas Flowing— Absorbs Vibration of Changing Pressures



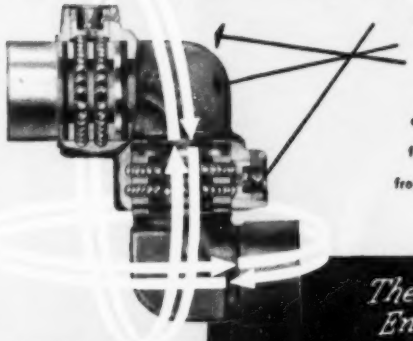
Not only do the stamina and flexibility of Chiksan Joints take expansion in their stride, they absorb pulsation and vibration. When the Plymouth Oil Company wanted a better way to handle the expansion and contraction of its 2500-3500 lb. natural gas re-pressuring line in its compressor station in Sinton, Texas, back in 1946, it tried Chiksan 2-inch high pressure ball bearing swivel joints. So successful were Chiksan Joints in this application, they were adopted for 3 and 4-inch lines for the same purpose. In addition, by placing regulators, gauges and other recording equipment on a bridge using Chiksan Joints, accurate readings of the instruments could be obtained.

Since 1946, not one of these Chiksan Joints has been replaced or even repacked, and they are giving the same economical, dependable service they did when first installed.

In Texas or California — all over America and all around the world — wherever production, processing or distribution depends on the flow of liquid or gas or on the dependability of hydraulic systems, there you will find Chiksan Ball Bearing Swivel Joints on the job — adding muscle and flexibility — cutting down on shut-downs and maintenance.

Whatever your business, if gas or liquid plays a part, Chiksan's Research and Development Division can help you add efficiency, safety and economy to your operation.

**Representatives in Principal Cities**
**Write for Catalog 53-C, Dept. PP-11**



**CHIKSAN Ball Bearing Swivel Joints are THE NEW TOOL of Modern Industry — with full 360° rotation in 1, 2, and 3 planes. Over 1,000 different types, styles and sizes have been developed for pressures and services from 28" vacuum to 15,000 psi and for temperature ranges from minus 75° to a plus 500° F. with packing materials for each specific type of service.**

CHIKSAN TRADE MARK REG.

*The Flow of Enterprise Relies on* **CHIKSAN** *Ball-Bearing Swivel Joints*

**CHIKSAN COMPANY • BREA, CALIFORNIA • Chicago 28, Illinois • Newark 2, New Jersey**
**Weil Equipment Mfg. Corp. (Division), Houston 1, Texas • Chiksan Export Company (Subsidiary), Brea, California • Newark 2, N. J.**

PROGRESS today in the power, processing and construction industries frequently depends upon new and varied types of heavy metal equipment.

Designing and building this equipment has long been an Alco specialty. From Tulsa to Trieste, from Pittsburgh to Palembang, Alco products ranging from 4-in. welded steel pipe to mammoth pressure vessels are giving outstanding service in all types of industrial installations.

This wealth of experience—applied by skilled engineers and craftsmen working with modern facilities—enables Alco to design and fabricate heavy equipment to meet rigid specifications.

Select your toughest heavy-equipment problem —then send it to your nearest Alco Products Sales Engineer. He'll quickly show you how Alco can produce the answer you've been looking for.

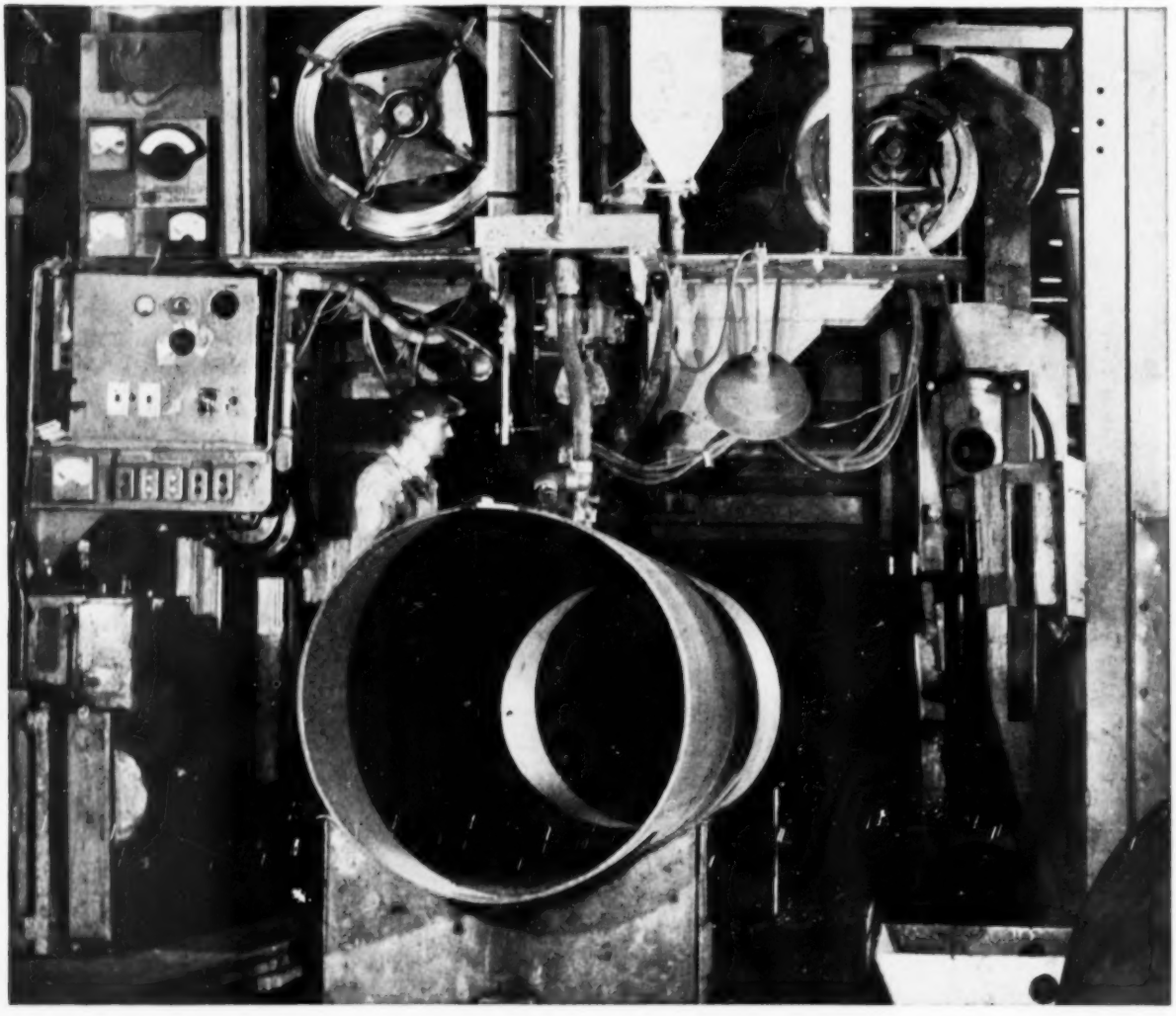
Alco Products Sales Offices are located in New York, Chicago, Dunkirk, Los Angeles, Kansas City, Houston, Tulsa and Beaumont.

*Alco speeds progress in*

# Answers to

Alco

**ALCO'S MODERN PRODUCTION FACILITIES,** designed to handle economically many difficult metal-fabricating operations, include this automatic submerged-arc welding machine. Welds made on this machine must pass the most rigorous leak tests ever devised for commercial welding.



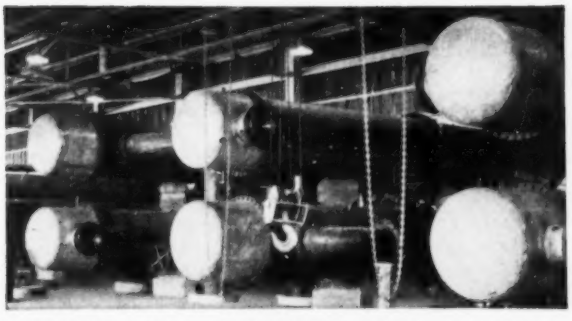
*power and petroleum, chemicals and construction, with...*

# New Industrial Problems

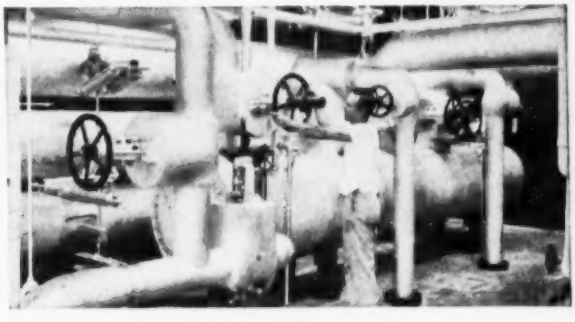
# ALCO

**ALCO PRODUCTS DIVISION**

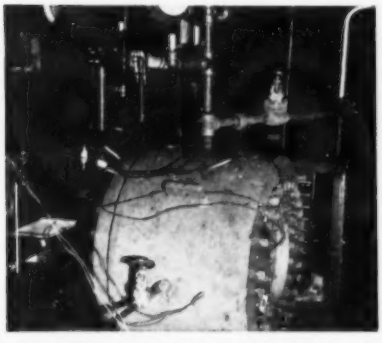
AMERICAN LOCOMOTIVE COMPANY • DUNKIRK, NEW YORK



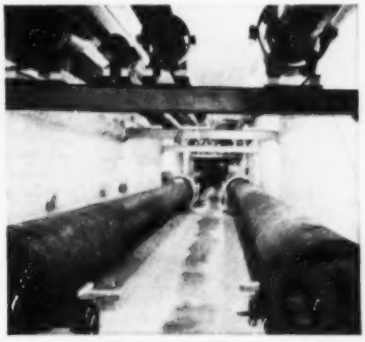
**CUSTOM-BUILT HEAT EXCHANGERS** ready for final piping in Canadian Chemical Company, Ltd.'s $55 million plant now under construction near Edmonton, Alberta. These units are among the more than 200 special reboilers and heat exchangers being supplied to the new Canadian plant by the Montreal Locomotive Works, Ltd., an Alco affiliate.



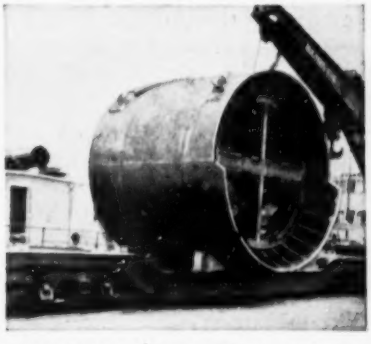
**ALCO FLEX-TUBE EVAPORATORS** incorporating many new features help boost efficiency at Carolina Power and Light Company's new 150,000 kw plant at Goldsboro, N. C. These specially designed Alco units produce vapor containing one part per million or less of mineral solids. Make-up to the system has been found to be less than one-half of one per cent.



**NEW HIGH-PRESSURE CLOSURE,** shown here during high-temperature tests, is typical of the many heavy-equipment improvements developed by Alco engineers for service throughout industry. (Reprints of article, "Engineering Development of Alco's New High-Pressure Closure," available upon request.)

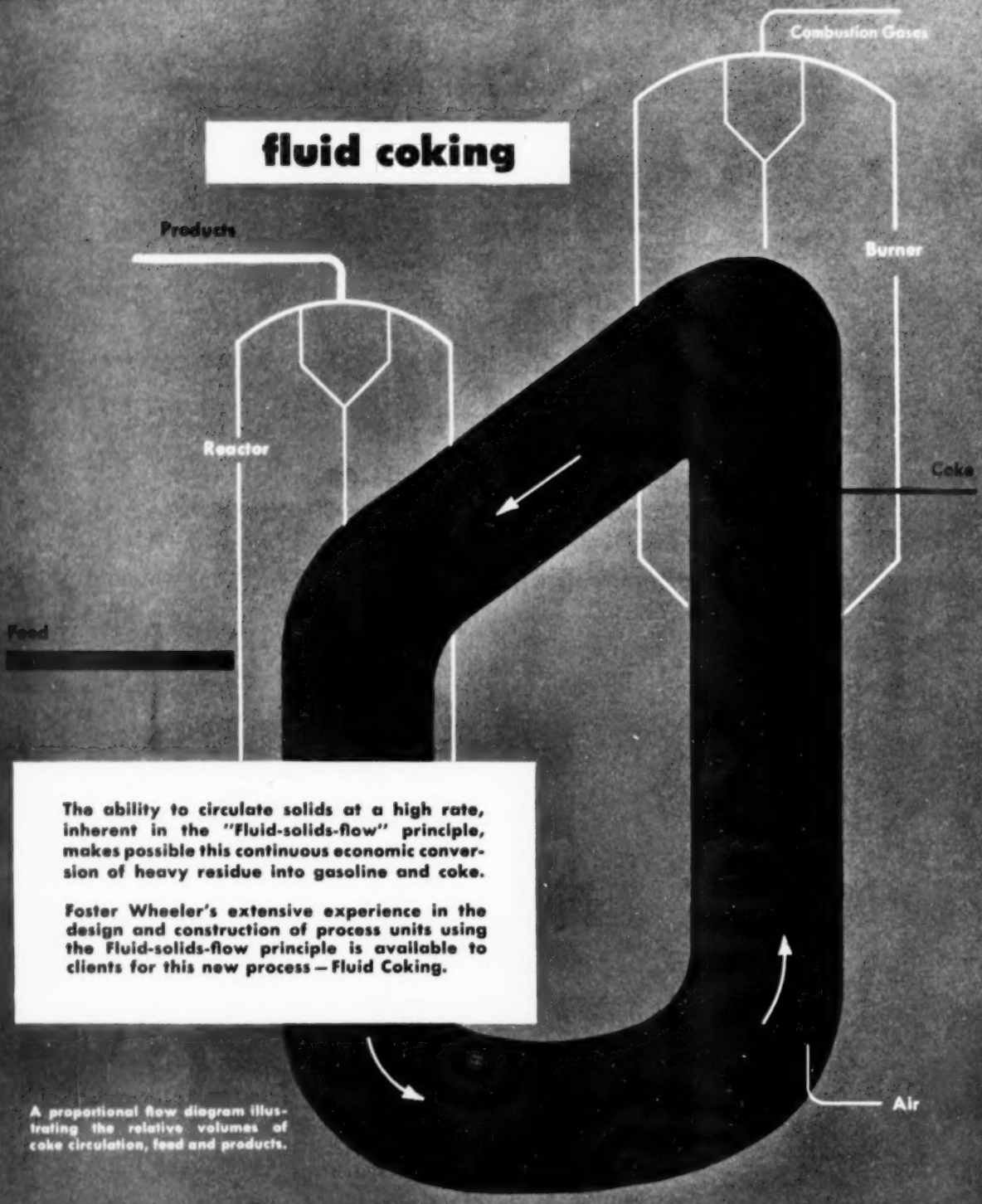


**ALCO WELDED STEEL PIPE** was furnished for the chilled water lines in the U. S. Government's new $4½ million walk-through tunnel, part of a Capitol Power Plant improvement project, now under construction at Washington, D. C. The 30-in. main lines (on tunnel floor) total about 9,280 ft., branch lines about 1,200 ft.



**GIANT TUNNEL SHIELDS** illustrate the variety of special heavy-metal equipment designed and fabricated by Alco for power, petroleum, chemical and construction companies the world over. Other items built by Alco to meet strict specifications range from tar stills to stripping towers, cement kilns to jet-engine containers.

# fluid coking




A proportional flow diagram illustrating the relative volumes of coke circulation, feed and products.

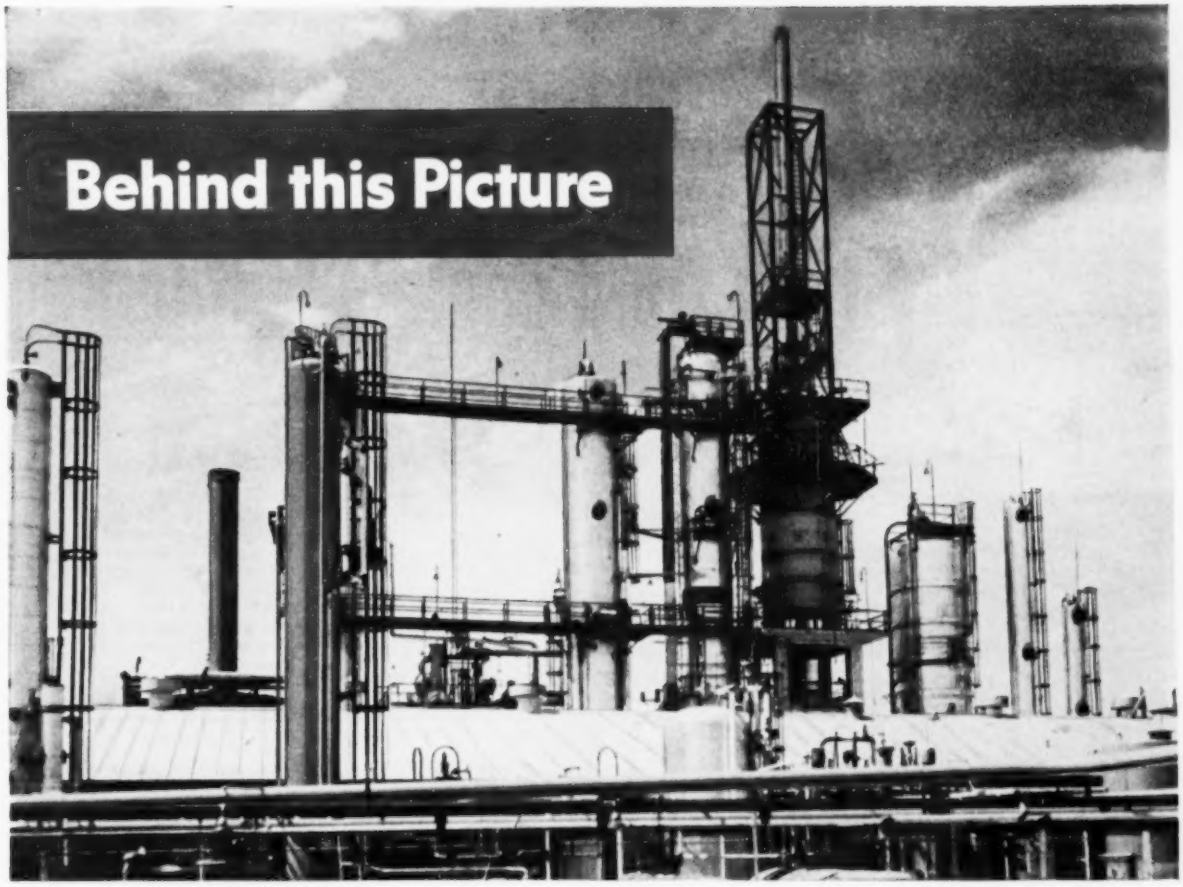
The ability to circulate solids at a high rate, inherent in the "Fluid-solids-flow" principle, makes possible this continuous economic conversion of heavy residue into gasoline and coke.

Foster Wheeler's extensive experience in the design and construction of process units using the Fluid-solids-flow principle is available to clients for this new process — Fluid Coking.

For further information on first cost, utilities, yields, operating economics, design and construction data, write to:

**FOSTER WHEELER CORPORATION**

165 BROADWAY NEW YORK 6, NEW YORK




# . . . a New Concept in Refinery Design

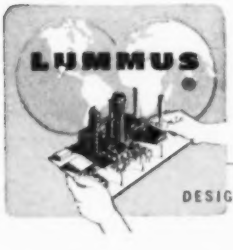
Up there is part of the new refinery at Wrenshall, Minnesota that we designed and built for International Refineries, Inc. With a capacity of 11,000 B/D, the new plant produces gasolines, and a wide range of fuel oils for home and industry.

Ultra-modern Wrenshall features single-unit construction. Distillation, Model IV Fluid Catalytic Cracking, gas recovery, treating, and polymerization are all combined in a single unit. The plant is a model of integrated processing—balanced to meet the needs of the area it serves.

This unique design lends itself to continuous flow and automatic control—so you'll also find these at Wrenshall. From crude charge to end products, flow of oil is continuous, doing away with intermediate storage, pipes, pumps and tanks. And it takes just three men, at one centralized station, to completely control the processing of the entire refinery.

What does all this mean? To International, it means a very substantial reduction in initial investment and operating costs. To us, it means another in a long list of jobs where we worked out new answers—used creative imagination.

Perhaps we can be of help on *your* next project.




**THE LUMMUS COMPANY**

385 MADISON AVENUE, NEW YORK 17, N. Y.

HOUSTON • CHICAGO • LONDON • PARIS • CARACAS

DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES

# 4 reasons why Trane dry-type fluid coolers last longer

## 1 Correct metal selection

A wide variety of types of metals are available for highly corrosive applications. Coils can be supplied in combinations of cupro nickel, admiralty, red brass, copper, aluminum, monel, steel, stainless steel and many other special metals. TRANE engineered products have solved corrosion problems of all types, yet obtained maximum heat transfer and maximum life from the fluid circuit.

## 2 Permanently bonded fins

In constructing the Extended Surface Coil—heart of the fluid cooler—TRANE bonds fin to tube *mechanically*. This bond is as permanent as the metals that form it and as strong as though fin-and-tube were one. Heavy support plates are used to reinforce and protect the coil and prevent tube sagging. And the exclusive TRANE Guide Flange cradles the coil to permit expansion within casing.

## 3 Extra-rugged construction

Framework of the TRANE Fluid Cooler is so strong it can be used for stationary or portable installation *without additional bracing*. Its simple structural design permits fastest possible erection. Yet it is more than strong enough to support core and accessories and withstand wind and shock load. Finish on the TRANE Fluid Cooler is a rubber-base paint that's completely weatherproof.

## 4 Freedom from vibration

TRANE Fluid Coolers run smoothly . . . quietly. They stay sound and tight longer because TRANE engineers have virtually eliminated the causes of vibration. Here's how: The variable-pitch fans are dynamically balanced. Solid, oversized fan shaft is firmly mounted in giant thrust bearings. Drive components are aligned at the factory and shipped assembled. Orifice ring is designed to *match* the fan.

**Trane Dry-Type Fluid Coolers** can be used profitably in hundreds of ways. Series GC for vertical discharge (shown above) is made in 6 regular sizes with fan diameters ranging from 72" to 144".

**Jacket water cooling** costs are cut to the minimum with the TRANE horizontal air stream Fluid Cooler. Series EC—available in 14 sizes with fan diameters from 18" to 120".

**TRANE** *pioneers in the science of heat exchange*

The Trane Company, La Crosse, Wis. • East. Mfg. Div., Scranton, Penn.
Trane Co. of Canada, Ltd., Toronto • 80 U.S. and 14 Canadian Offices

# SANTOPOID 33

## Multipurpose Gear Lubricant Additive and foam inhibitor

Field experience has proved Santopoid 33 an ideal additive for compounding gear lubricants to meet the demands of both high-speed passenger car and high-torque truck and bus operation.

And Santopoid 33 offers an important extra — its foam-inhibitor content. Santopoid 33 contains a stable anti-foam agent that retains effectiveness over long periods of storage. Enough stable anti-foamant is present in Santopoid 33 so that the final gear-lubricant blend is permanently protected against foaming in service.

For more information on this versatile additive, write today to MONSANTO CHEMICAL COMPANY, Organic Chemicals Division, 800 North Twelfth Blvd., St. Louis 1, Missouri.

*Santopoid: Reg. U. S. Pat. Off.*

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CHEMICALS – PLASTICS

SERVING INDUSTRY...
WHICH SERVES MANKIND

**In catalytic**

**reforming**

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# CATALYST

**That's why**

**you should know the story**

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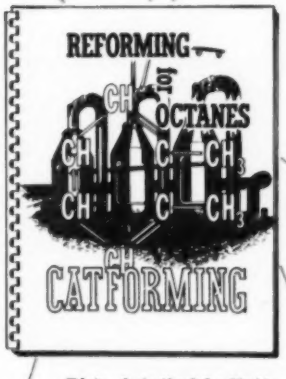
# CATFORMING

# THAT COUNTS

Many years have gone by since catalytic reforming was first utilized by the petroleum industry. As with many developments, earlier methods fell far short of ideal.

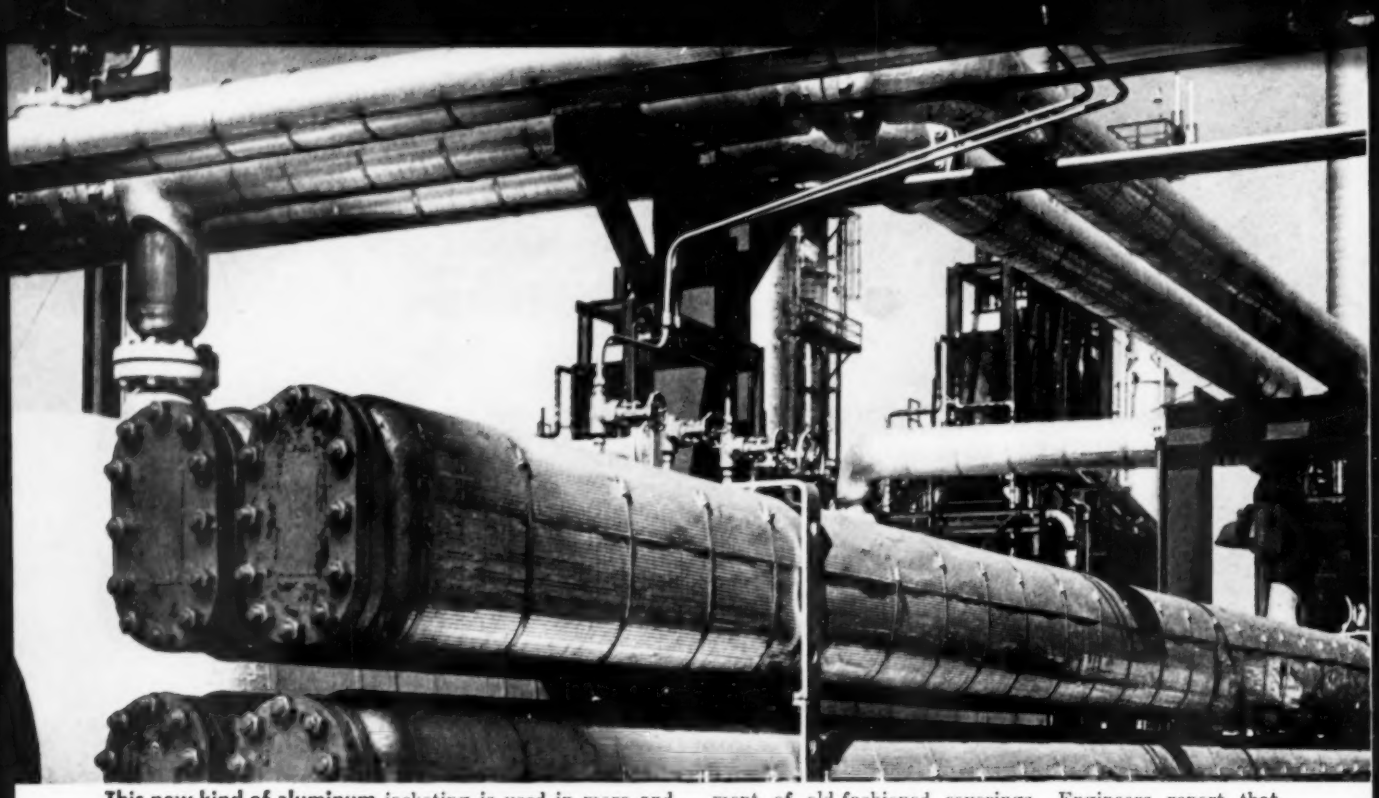
Many years ago Atlantic's engineers and chemists looked well ahead to the more demanding needs of industry-wide commercial application. They devoted themselves to continuous and unrelenting laboratory research. One catalyst after another was rejected for failing to meet Atlantic's projected ideal catalyst. Finally, a catalyst possessing new characteristics and demonstrating an ability to surmount the shortcomings of previously developed catalysts was found. This completely new catalyst, combining the advantages of improved selectivity, greater stability, excellent resistance to poisoning, and easier regeneration, is the heart of CATFORMING.

CATFORMING is now in successful commercial operation, furnishing positive proof that IT'S THE CATALYST THAT COUNTS. You are invited to share the many benefits of CATFORMING by joining our ever-growing list of licensees. Call or write for our new detailed bulletin for your introduction to CATFORMING. The Atlantic Refining Company, Research and Development Department, P. O. Box 8138, Philadelphia 1, Pa. (Telephone, Howard 5-2345.)




*This detailed bulletin yours for the asking!*

ATLANTIC



**This new kind of aluminum** jacketing is used in more and more outdoor processing plants to protect insulated towers, vessels, lines—it eliminates costly maintenance and replacement of old-fashioned coverings. Engineers report that Childers Jacketing has advantages not found in expensive heavy sheet aluminum, costs less to buy, far less to apply.

# New Aluminum Jacketing Protects Insulated Lines...Cuts Costs 28%

## How 986 of America's Leading Companies Saved Money By Weather-proofing Insulated Lines This New Way:

**A two-man crew can apply** the jacketing fastest. Only tools are a pair of pliers and a wedge or screw driver as shown here. Note how easily the jacketing forms around the pipe.

**Aluminum strapping can be** pulled plenty tight enough with just pliers like this. No special strapping tool needed. Strapping is pulled down between lugs and bent over.

**Up-to-date appearance,** low cost, and long life go hand in hand in a new aluminum jacketing for insulated lines. Developed by Childers Manufacturing Co., Houston, Texas, it is the first permanent weather-proofing that offers both low initial cost and low application cost.

**Childers Jacketing,** made of tough 3S aluminum alloy for maximum corrosion resistance, lasts years without painting or other maintenance. It costs less than even the cheapest kind of weather-proofing, when the cost of one paint job is considered. Savings run up to 28%.

**Cost-minded engineers** are also impressed with the gleaming beauty of Childers Jacketing that means "good plant housekeeping."

**Available with moisture barrier** attached, for use over 85% magnesia insulation.

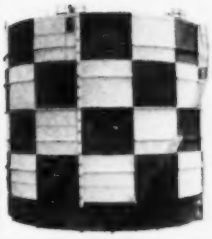
**5 years of tests** and major installations in 986 of America's leading processing plants, refineries, and power plants have proven the advantages of Childers Aluminum Jacketing over other types.

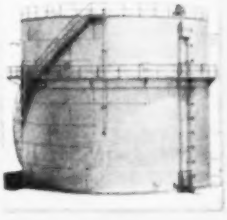
**Try this low-cost protection** in your plant. Write today for engineering data and information about how you can order a 400 sq. ft. roll to test on one of your insulated lines. No obligation.

**Address Childers Manufacturing Co., Dept. TR-6, 3620 W. 11th St., Houston 8, Texas.**

Engineering representatives in all principal cities to work with you on your problems.

**This is how the flexible,** easy-to-handle Childers Jacketing arrives at the job site. It is in convenient rolls 4 feet wide and 100 feet long—just right for one man to handle—and is available either with or without a moisture barrier attached on the back of the .006" aluminum "skin." It can be cut to proper lengths using any flat table and a straight-edge. (Advertisement)

users of chemical process  and industrial gases

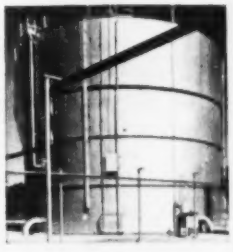
get rid of  weather-worries and operating costs

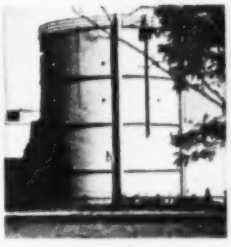
with the..

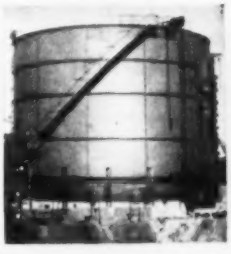
# Wiggins Gasholder

## by GENERAL AMERICAN

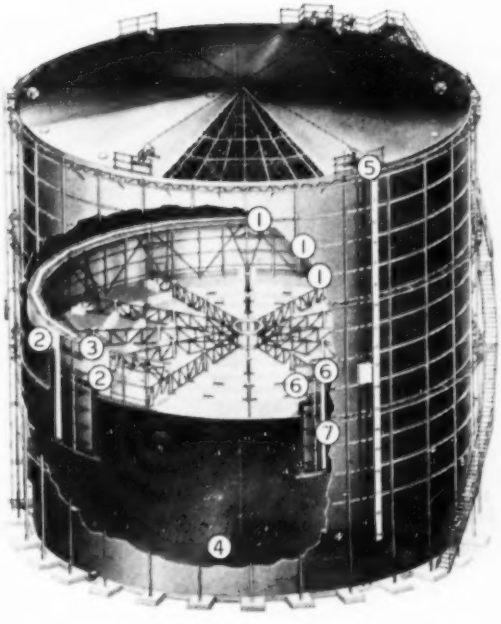
More than 50 users of Wiggins Gasholders can now testify to the remarkable savings in operating costs and maintenance expense which only this 100% dry seal gasholder (no water, no tar, no grease) gives them. Write for full information.







Visit us at the 24th Exposition of Chemical Industries in Philadelphia, Nov. 30—Dec. 5, Booths No. 42 and No. 44, Commercial Museum and Convention Hall.




1 TOP SECTION OF SHELL COMPLETELY VENTILATED

2 WIDE CLEARANCES SIMPLIFY OPERATION

3 GAS-TIGHT FRICTIONLESS SEAL NOT AFFECTED BY WEATHER

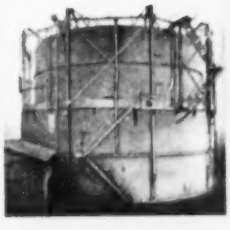
4 PISTON RESTS ON BOTTOM—LESS THAN ½ OF 1% FOR PURGING

5 LEVELING DEVICE—INDEPENDENT OF SIDE WALL—KEEPS PISTON LEVEL

6 FENDERS PREVENT ALL TENSION IN SEAL

7 SHELL IS GAS-TIGHT UP TO SEAL CONNECTION

PISTON RISES NEARLY TO TOP—MINIMUM OF WASTE SPACE
CAN BE BUILT ANY SIZE • NO CONTAMINATION OF GAS



### CONVERSION EASY — OFTEN ADDS CAPACITY

Your old gasholder can be quickly converted to a Wiggins type with all the Wiggins advantages.

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**135 South LaSalle St. • Chicago 90, Illinois**
*OFFICES IN PRINCIPAL CITIES*
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***Plants:*** Birmingham, Ala. • East Chicago, Ind. • Sharon, Pa.
***In Canada:*** Toronto Iron Works, Ltd., Toronto, Ontario

# Graphic control...*for leading industries*

The well-established trend to centralized graphic instrumentation has brought with it many specific advantages to the operation of complex, modern processing units. And to realize most fully the potential advantages of improved efficiency, simpler supervision and better coordination, many leading companies have turned to Honeywell graphic control.

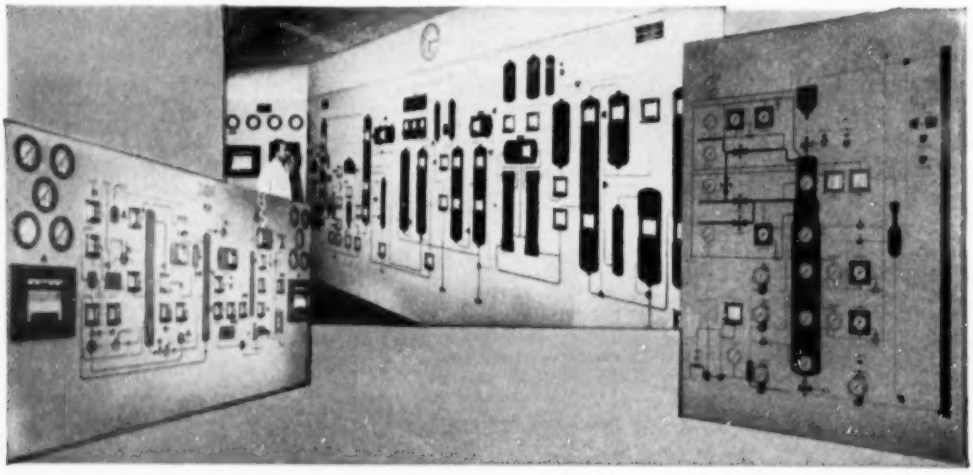
Among the engineering, construction and producing organizations which use Honeywell panels are some of the best-known names in their fields. The ever growing list includes:

C. F. Braun
Catalytic Construction Co.
The Fluor Corporation Ltd.
Foster Wheeler Corp.
Gulf Oil Corporation
Imperial Oil of Canada
M. W. Kellogg
The Lummus Co.
Pan-Am, Southern
Phillips Petroleum Co.
The Refinery Engineering Co.
Shell Oil Co.
Sinclair Refining Co.
Socony-Vacuum Oil Co.
Standard Oil Co. of California
Standard Oil Co. of Indiana
Standard Oil Co. of New Jersey
The Texas Company
Tide Water Associated Oil Company
Union Oil Co. of California

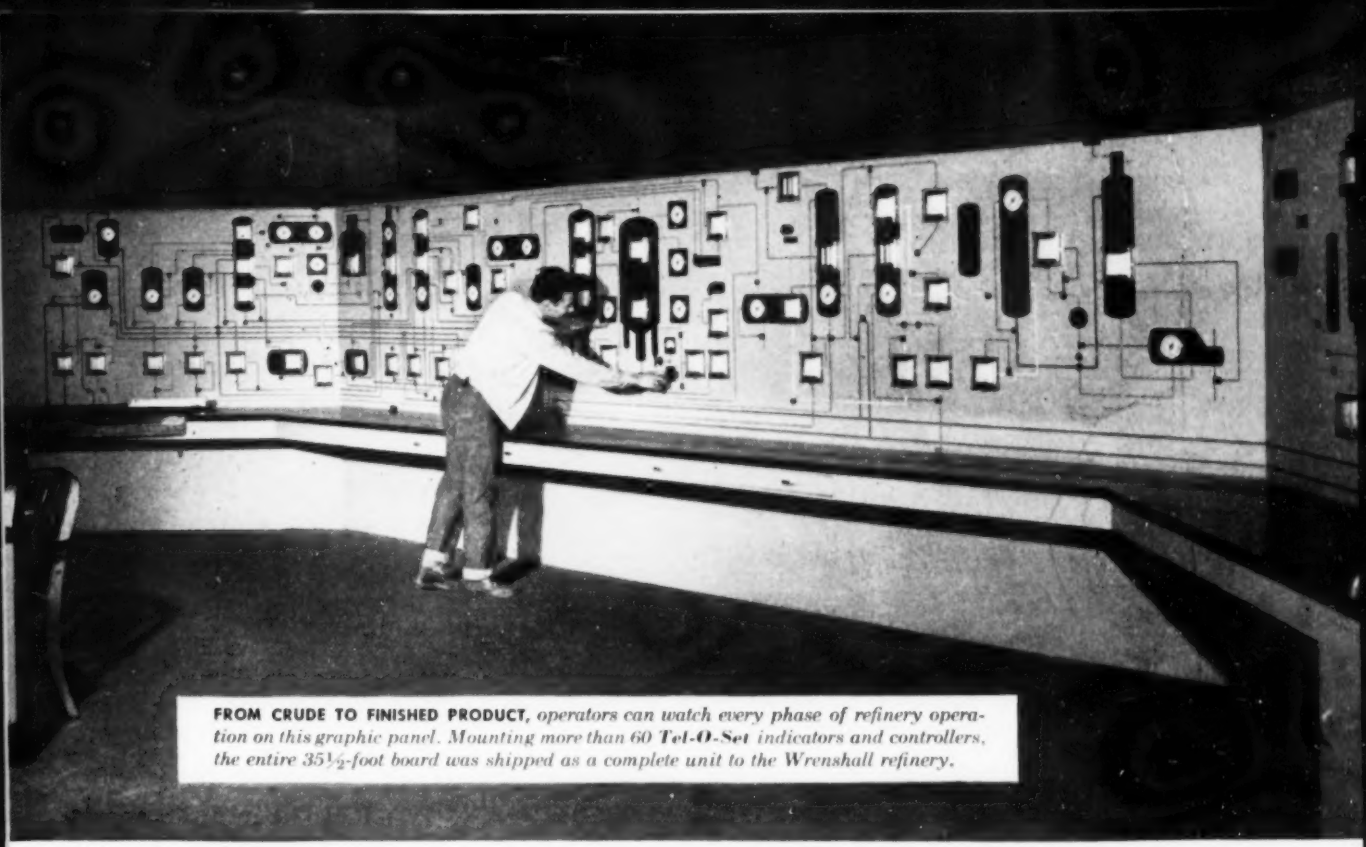
### Reasons for acceptance

Behind this industry-wide acceptance stand several definite reasons. First is system engineering . . . by graphic panel specialists who translate process requirements into an integrated, harmonious design. Second is instrumentation . . . including a full line of *Tel-O-Set* miniature indicators, recorders and controllers, and *ElectroniK* instruments for supplementary recording, which enable Honeywell to satisfy the requirements of every phase of process control. And third is workmanship . . . skilled assembly either in a manufacturing department devoted exclusively to this work, or, if desired, at the job site by our own experienced branch installation crews—an organization built up over 15 years for the installation of industrial and commercial control systems.

# Graphic control *centralized*



**FUNCTIONAL DESIGN** *for maximum efficiency is the keynote of Honeywell graphic instrumentation. These typical panels show a few of the varied types which have been built for varied process applications.*



**FROM CRUDE TO FINISHED PRODUCT,** *operators can watch every phase of refinery operation on this graphic panel. Mounting more than 60* ***Tel-O-Set*** *indicators and controllers, the entire 35½-foot board was shipped as a complete unit to the Wrenshall refinery.*

# for complete refinery *on a single Honeywell panel*

THE MOST up-to-date concepts of petroleum processing were embodied in International Refineries' new plant at Wrenshall, Minnesota. Designed and built by the Lummus Company, this refinery produces straight run, cracked and polymer gasolines, diesel and other fuel oils, all of which are distributed by Western Oil & Fuel Co.

An outstanding feature of this new refinery is its continuous flow operation . . . no intermediate storage tanks are needed between processing stages. This "straight through" design naturally calls for precise, closely integrated control of related processes. To meet these exacting control requirements, refinery and design officials selected Honeywell graphic control.

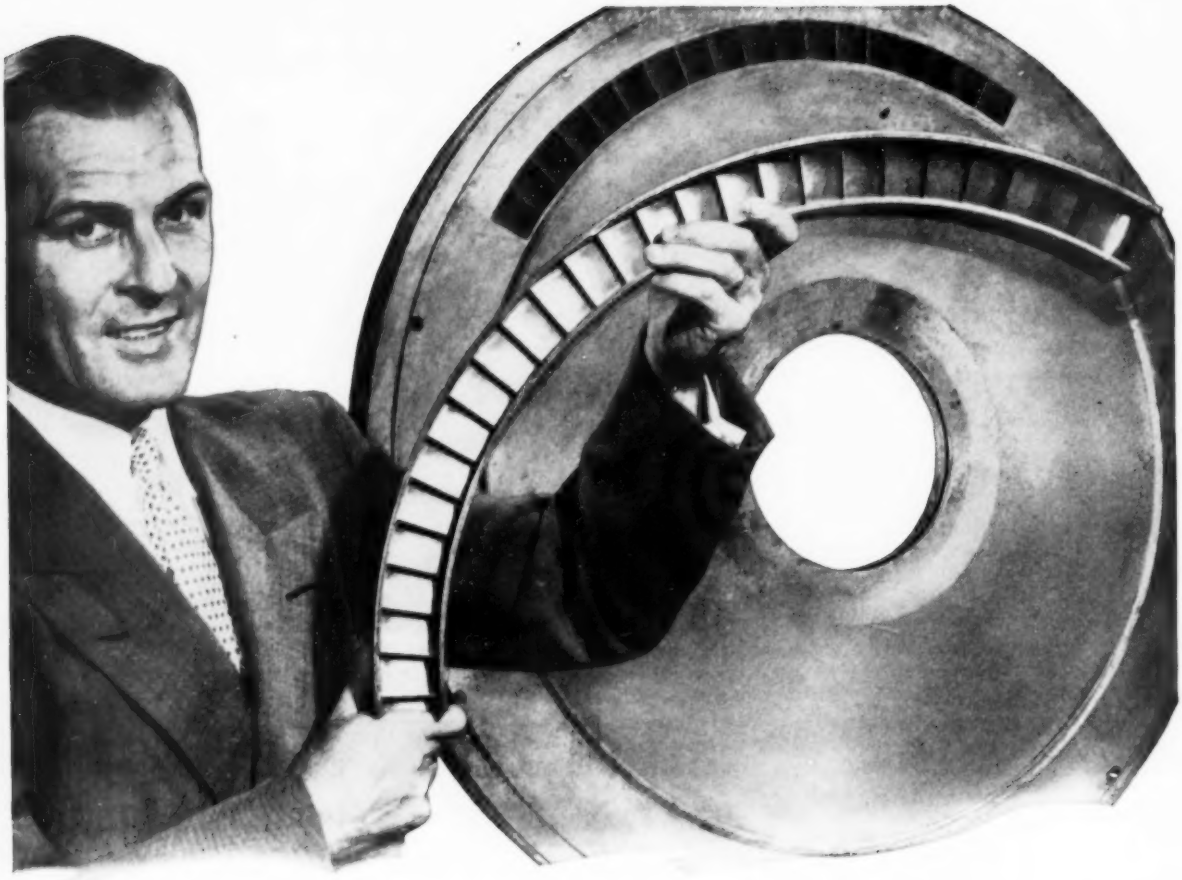
The big graphic panel shown above combines all the instrumentation for eight different refining processes. Operators can follow the entire functioning of the plant from crude to finished products, from this single control center. Worked out in detail by Honeywell design specialists, this panel does the job that would ordinarily require four or more separate panels. Not only were substantial savings effected in space, but the panel affords complete centralization of plant control . . . flexibility to meet seasonal variations in product demand . . . and maximum efficiency of process supervision, both for operators and for management personnel.

Your nearby Honeywell sales engineer will welcome the opportunity to discuss your graphic control requirements. Call him today . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4582 Wayne Ave., Philadelphia 44, Penna.

● **REFERENCE DATA:** Write for Bulletin 85-20, "Centralized Instrumentation . . . unlimited."

MINNEAPOLIS
**Honeywell**
BROWN INSTRUMENTS
*First in Controls*



# "This weld-free steam path speeds steam flow, preserves turbine efficiency"

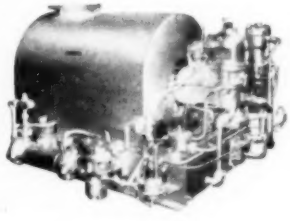
One reason for the higher, *long-term* efficiencies in Westinghouse Turbines is the special attention given to *preserving* the designed steam flow path. Example: diaphragm nozzle sections where every single weld fillet has been *eliminated* from the steam path. Here's how:

The nozzle vanes are first assembled between inner and outer strips, held in a precision jig. The nozzle vanes project into accurately spaced holes in the strips. This permits welding around the *outside* of the section—*completely* away from the steam path. The complete section is then welded into the diaphragm. Specially engineered for use in multi-stage turbines, this precise manufacturing technique provides an absolutely smooth and accurate steam path without the slightest weld fillet or other deviation from design to impair stage-to-stage flow. It is extra assurance that driving power and efficiencies will be maintained throughout the life of the turbine.

The weld-free diaphragm nozzle is just one of the continuing engineering refinements Westinghouse uses to give its turbines unusual *long-term* efficiency. The knowledge and manufacturing techniques gained from over 50 years' experience—on 1 hp to the largest made—make possible this and the many other features which deliver decade after decade of unfailing service. Make sure your next steam drive has *long-term* efficiency. Expert Application Engineers will help you select the right unit from a complete line of General-Purpose Turbines. Call your local Westinghouse office or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-50561

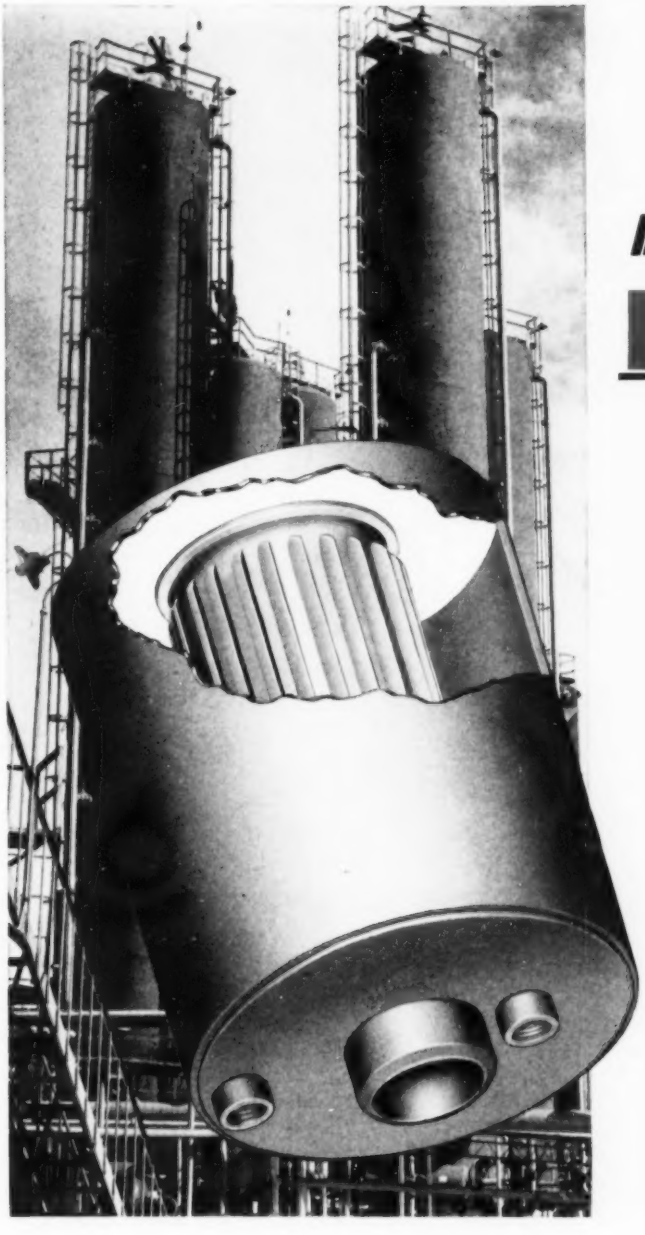
**Multi-stage, Single-valve, General-purpose Turbine**

One of the multi-stage line which benefits from improved steam flow using weld-free diaphragm nozzles. Available in ratings from 100 to 2000 hp, 1000 to 7500 rpm, for driving all types of pumps, fans, compressors, generators and special-purpose machines. This advanced design is adaptable to almost any steam condition.



YOU CAN BE SURE...IF IT'S Westinghouse

*Turbines for every industrial use*



# Recover Valuable Entrainment In Processing Vessels With Hi-eF PURIFIERS!

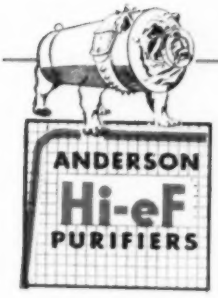
**OVER 99% EFFICIENCY**

**ENABLES ENGINEERS TO OVERCOME MANY ENTRAINMENT PROBLEMS**

Many petroleum engineers find Hi-eF Purifiers one of the easiest ways to increase process efficiency. Installed inside or on the line near process vessels such as fractionating columns, bubble cap towers, packed towers, stills and similar equipment, purifiers prevent carryover from leaving the vessel. This steps up process efficiency in 5 ways:

1. Permits towers to be operated at greater capacities.
2. Prevents valuable solids from leaving the process vessel.
3. Stops contamination of subsequent process with guck, solids, etc.
4. Avoids contamination of distillate and other products and processes with foreign entrainment.
5. Increases operating efficiency of process equipment.

Refiners using the Hi-eF method recognize the superiority of these stationary, maintenance free, filterless separators. For a solution to your problem, mail coupon for further details.




*Watchdogs of STEAM • AIR • GAS • VAPOR • Pipelines and Equipment*

**THE V. D. ANDERSON COMPANY**

**1974 West 96th Street • Cleveland 2, Ohio**

UPFLOW INTERNAL PURIFIER

LARGE LINE TYPE PURIFIER

DOWNFLOW INTERNAL PURIFIER

RECEIVER TYPE PURIFIER

Please send me a copy of Bulletins describing your purifiers for the petroleum industry.

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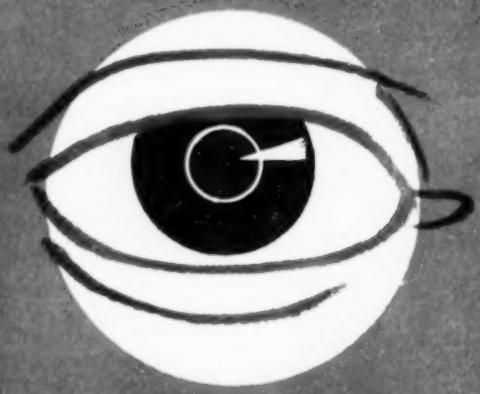

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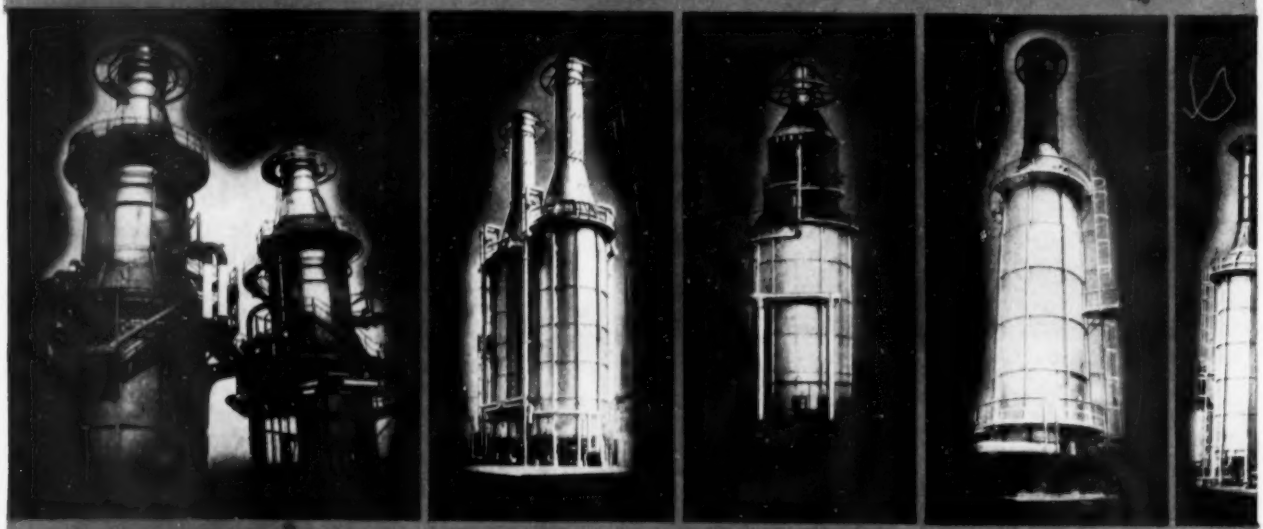

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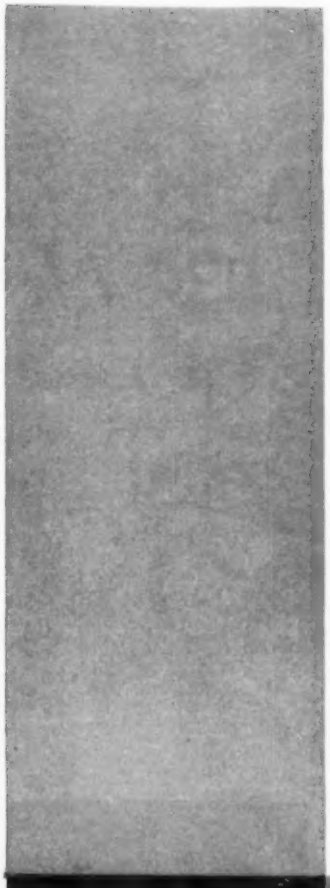

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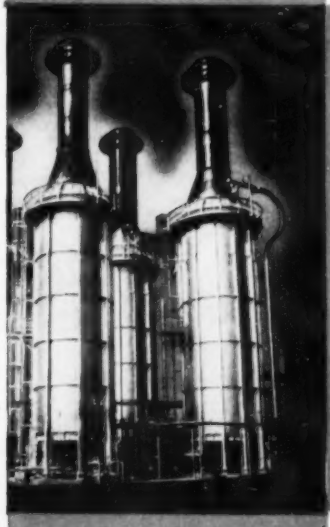
Uniform heat distribution, the most desirable characteristic of any fluid heater, is created in an Isoflow furnace as the result of the following design characteristics:

1. Individual burners, symmetrically spaced with relationship to the tubes, create a symmetrical flame pattern with relation to the heating elements.
2. The metal cone at the top of the combustion chamber re-radiates to the tubes, also diverts products of combustion progressively closer to the tubes, and combines the proper proportion of radiant and convection heat to give the uniform heat intensity at the upper portion of the combustion chamber.
3. The combustion gases are diverted behind the tubes so that the gases recirculate from the top of the heater downward, behind and between the tubes, thus increasing the heat input to the rear of the heating elements by convection.
4. The recirculated gases also serve to reduce the combustion temperature, reducing the heat intensity at the bottom of the furnace.

The above design factors in Isoflow heaters, combined with the angle of the cone, provide the uniform heat distribution required in heaters for the most efficient process operation.



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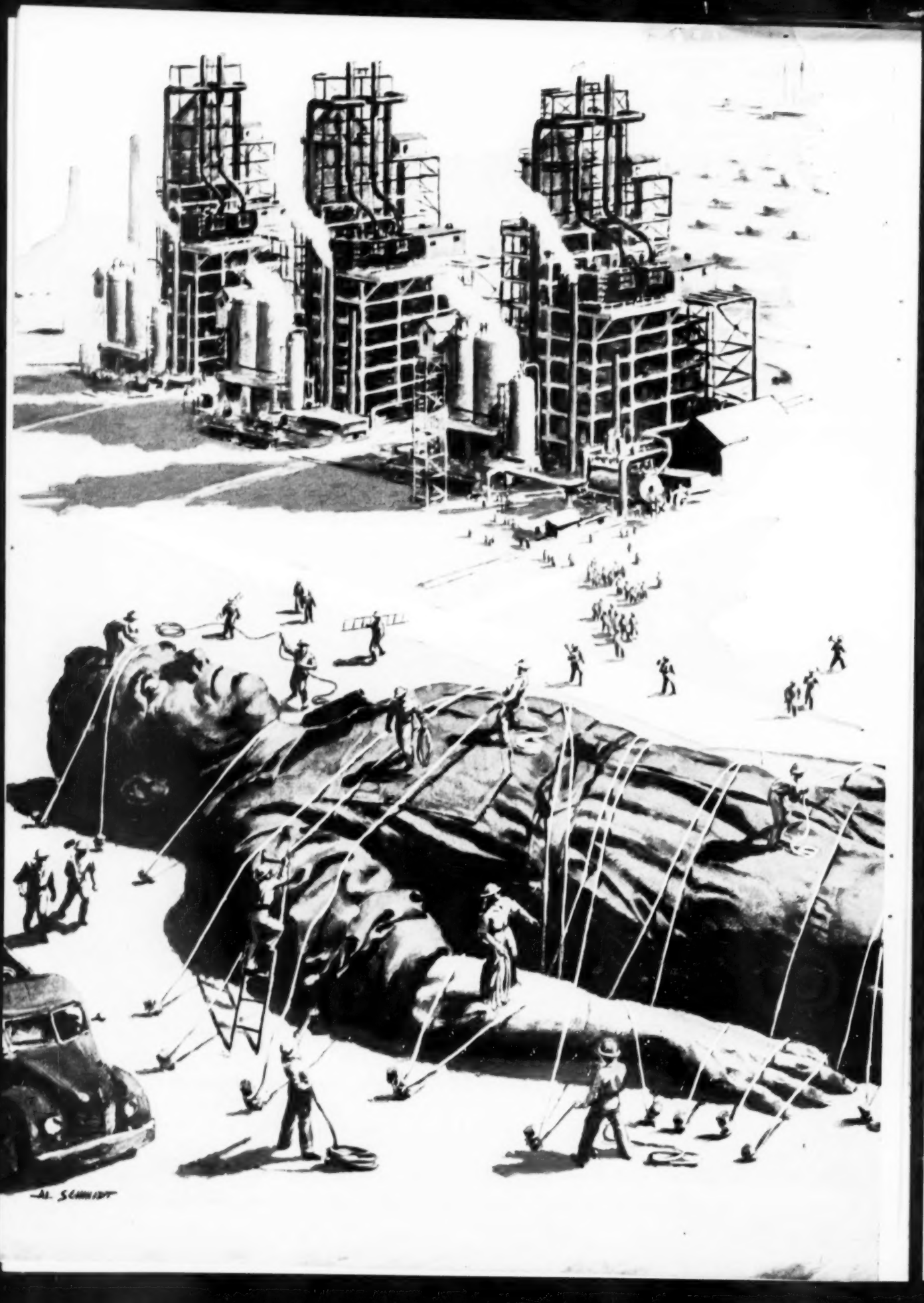

AL. SCHMIDT

# How Would You Go About Taming a Giant?

FOR MILLIONS OF YEARS the Giant slept.

In 1863, Man disturbed his mighty slumber, tamed him and put him to work for the good of all.

The Giant was called Petroleum.

How did enterprising men go about harnessing this stupendous new source of energy?

Here is how they did *not* go about it:

They did *not* turn the problem over to a government agency.

They did *not* say, "Whale oil is good enough. Why bother with this newfangled stuff?"

They did *not* say, "Too many problems involved. Too many risks. We might lose our shirts."

They *did* get to work and promote risk capital for drilling.

They *did* make this new source of energy available to all the people.

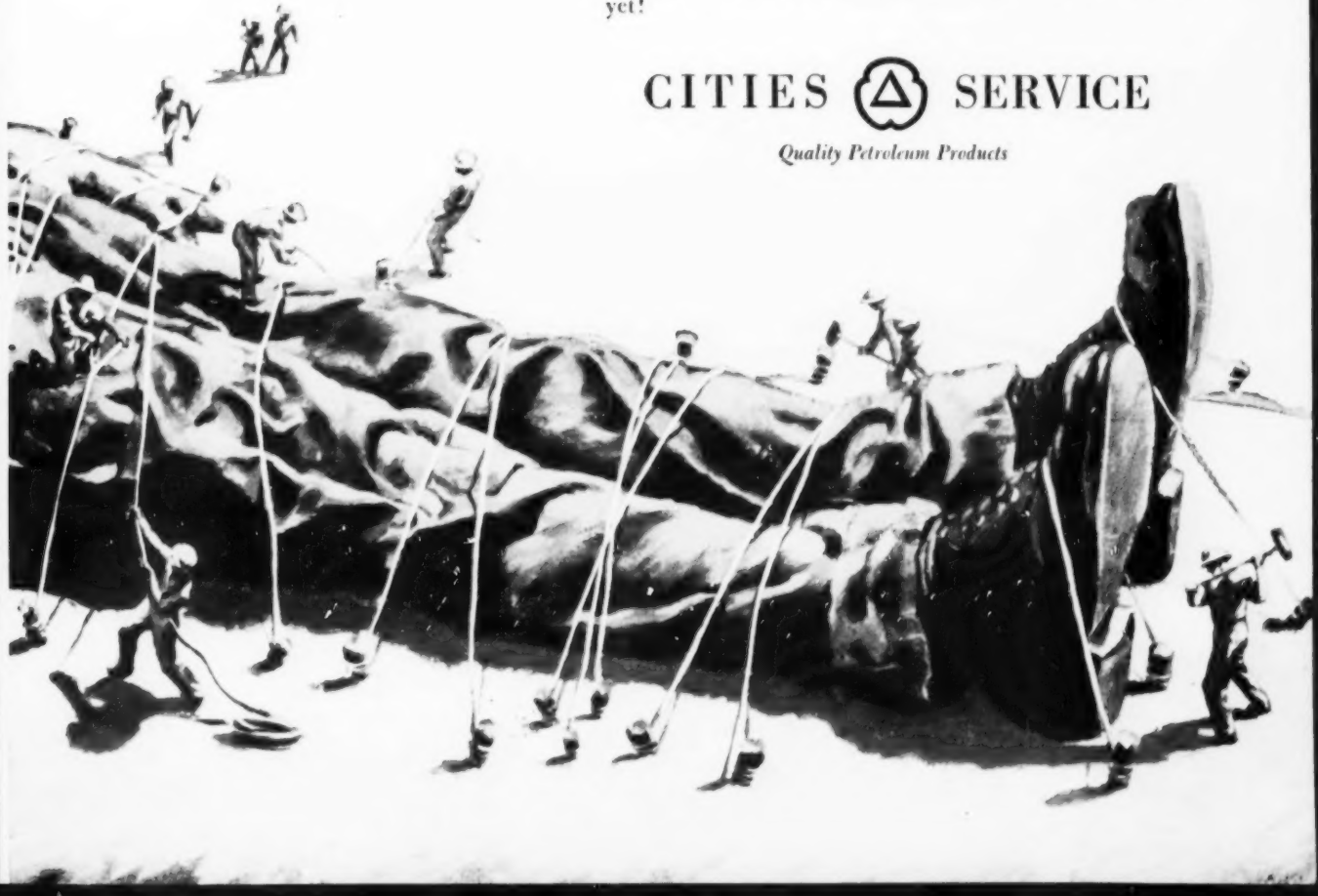
They *did* seek—and find—new ways to put the Giant's talents to work making hundreds of new products, creating thousands of new jobs.

Among these energetic giant-tamers were men of Cities Service. They had begun as processors of whale oil. They were quick to see the possibilities of "rock oil." They were among the first to study the sciences of combustion and petro-chemistry.

The petroleum Giant is now a docile servant of mankind. It has made our lives easier in countless ways. But Cities Service researchers say it has muscles it hasn't even used yet!

CITIES SERVICE

*Quality Petroleum Products*



# write your music for Quartet

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Solos are grand in a concert, but to have the petroleum processing industries singing the praises of your product, you need *an arrangement for quartet!*

There's one arrangement for your advertising which reaches all four important areas of this great industrial group. It's called ***Petroleum Processing;*** it goes directly, effectively, forcefully to all four groups:

1. Petroleum refining.
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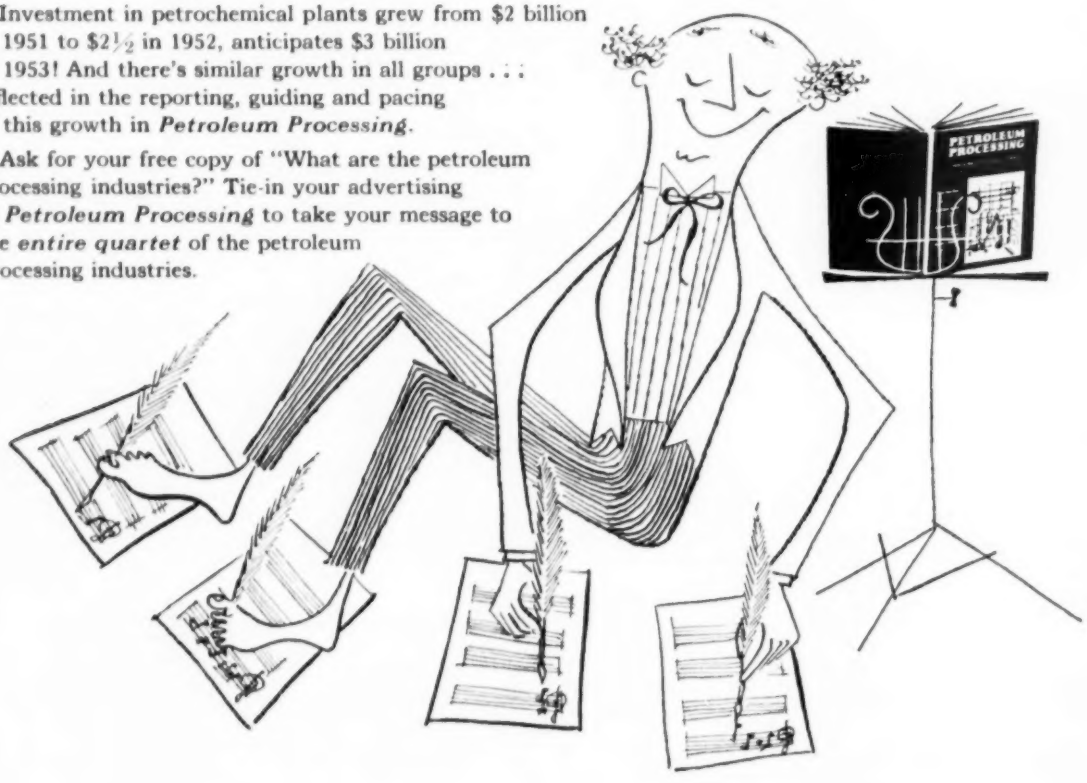
Investment in petrochemical plants grew from $2 billion in 1951 to $2½ in 1952, anticipates $3 billion in 1953! And there's similar growth in all groups . . . reflected in the reporting, guiding and pacing of this growth in ***Petroleum Processing***.

Ask for your free copy of "What are the petroleum processing industries?" Tie-in your advertising in ***Petroleum Processing*** to take your message to the ***entire quartet*** of the petroleum processing industries.




**PETROLEUM PROCESSING**

A McGraw-Hill Publication

Publication office:
1213 West Third Street
Cleveland 13, Ohio

# REFINERY PROCESS NEWS

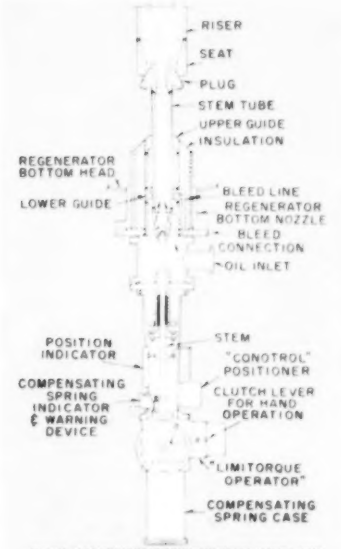
PUBLISHED BY REFINERY PROCESS DIVISION, THE M. W. KELLOGG COMPANY NOVEMBER 1953

## Patented Plug Valve Key to Orthoflow's Operating Ease

Unique mechanical features of the Orthoflow Fluid catalytic cracker are the plug valves which replace the more conventional slide valves. Designed and patented by Kellogg, they might well be termed the key to the decreased investment, easy operation and low maintenance cost of the Orthoflow.

Not only do they make feasible the elimination of expansion joints in certain of the Orthoflow units, but also they are much more easily maintained than slide valves. Actually, the new valves make possible the basic advantage of the Orthoflow: Straight-line flow of catalyst with its concomitant reduction in erosion.

The plug valves are so arranged that they can be unflanged, lowered from the bottom head and taken to a shop for maintenance while the rest of the unit is being inspected and repaired.




PLUG VALVE FOR REGENERATED CATALYST

Although the plug of the valve is subjected to the same type of erosion that is encountered in slide valves, and its rebuilding or replacement must be expected after about a year of service, the valve seat and the straight catalyst lines themselves have proven remarkably free of erosion difficulties. Only minor repairs have so far been necessary.

All these factors, coupled with the ease of shut down and start up, make the Orthoflow design a highly attractive one.

## Combination Processing Can Reduce Total Investment Costs by More Than 20%

Recently completed economic studies by Kellogg comparing combination refining with conventional sequence-type unit-processing show the remarkable savings in investment and operating costs as well as the improved yields that may be obtained through the integration of a petroleum refinery.

Today it is possible by skillful integration not only to cut the cost of the processing equipment from five to 15% but also to reduce the cost of offsite facilities by as much as 25%. The overall effect results in the possibility of erecting complete new combination refineries at perhaps 20% less than the cost of building comparable capacity in individual process units.

Important savings also result from reduced operating costs such as labor, fuel, power, steam, water, and maintenance.

Although there are savings in utilities—particularly through the conservation of heat due to the virtual elimination of intermediate storage—and in maintenance charges, the largest single reduction in direct operating costs for combination units results from smaller labor requirements. Total operating personnel needs may be slashed by as much as 30%.

In addition to the savings already mentioned, the combination plant has a further advantage in improved yields due to a reduction in evaporation and other losses. An increase in gasoline yield of about one percent may be expected in a combination unit—an important source of increased earnings and quicker payout. (Shown above is a typical modern combination catalytic refinery.)

NOTE: For more extensive study of combination refining and its advantages send for KELLOGGRAM No. 1, 1953 which compares the economics of 10, 20 and 40,000 BPD combination units with conventional plants of equal capacities.

SEE REVERSE SIDE

CONTINUED FROM PRECEDING PAGE

# Operating Data Reveals Kellogg Reactor Efficiency

Recent operating data from two relatively new sulfuric acid alkylation plants clearly reveal that the Kellogg cascade reactor is highly effective in producing excellent yields of high-octane alkylate with a minimum consumption of acid.

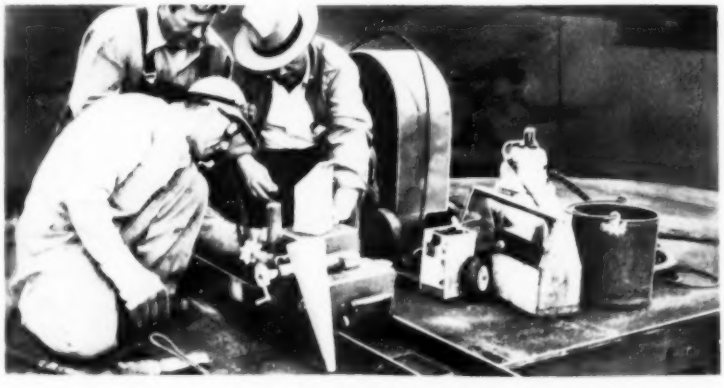
While the data from both units indicate efficient performance, it is interesting to note the difference in the yield, octane rating and consumption of acid in the instance where the feed contains a high percentage of propylene.

As shown in the accompanying tables, propylene is a satisfactory feed, but it does not produce as high octane numbers or consume as little acid as butylene alkylation.

| | | | Butylene Mo. % | Propylene Mo. % |
|---|---|---|---|---|
| Olefin feed composition | | $C_3H_6$ | 6.4 | 23.5 |
| | | $C_4H_8$ | 19.5 | 15.2 |
| | | $iC_4H_{10}$ | 33.8 | 29.9 |
| | | $nC_4H_{10}$ | 17.4 | 4.2 |
| | | $C_5H_{12}$ & $C_6H_{14}$ | 20.5 | 23.8 |
| | | $C_7H_{16}$ | 2.4 | 3.4 |
| | | Total | 100.0 | 100.0 |
| Acid consumption lbs./gal. total alkylate | | | 0.7 | 1.05 |
| Light alkylate inspections | °API | | 70.8 | 72.8 |
| | ASTM Dist. °F | IBP | 120 | 110 |
| | | 10 | 180 | 150 |
| | | 20 | 200 | 170 |
| | | 50 | 220 | 200 |
| | | 90 | 240 | 240 |
| | | EP | 340 | 320 |
| | | % REC | 98.0 | 99.0 |
| | RVP | | 5.6 | 5.8 |
| | Octane | F-1 Clear | 96.2 | 93.4 |
| Light alkylate yield (Basis total alkylate) | | | 95 LV. % | 93 LV. % |

## Kwinana Refinery Takes Shape

Work is proceeding steadily on the new Anglo-Iranian refinery at Kwinana, Australia. (Above) Progress on the Orthoflow Fluid catalytic cracking unit . . . the guy derrick is just being installed for lifting the various towers and vessels onto the foundations which may be seen in the center of the site. The unit will be a Model "B" Orthoflow in which the regenerator is located on top of the reactor to reduce compressor horsepower requirements. (Below) A typical example of the use of standard shop equipment in field fabrication. Shown is a portable continuous welding machine, being used here for the fabrication of tank shell plate.



# Autofining Economics are Attractive . . .

Although Autofining, AIOC's new desulfurization process licensed by Kellogg, shows excellent economics in comparison with acid treating as a method of removing sulfur from kerosene, it shows an even more attractive payout time when it is used to treat gas oil.

The economic summary below takes into account direct operating costs and treating losses, but excludes taxes, depreciation, interest and royalty for both treating methods. Direct operating costs include labor, maintenance, utilities, chemicals and catalyst. Acid required for treatment of kerosene and gas oil is 15 and 40 lbs./bbl. respectively. The payout periods on incremental investment for the Autofining cases are very short, and the Autofining process appears to be both an economical and flexible method of reducing the sulfur content of straight-run petroleum distillates.

| | KEROSENE (Sulfur reduced from 0.4 to 0.03 wt. %) | | GAS OIL (Sulfur reduced from 1.1 to 0.6 wt. %) | |
|---|---|---|---|---|
| Investment, 3,500 BPSD Plant | $650,000 | $320,000 | $800,000 | $320,00 |
| Direct Operating Costs, $/Bbl | 0.095 | 0.218 | 0.104 | 0.485 |
| Treating Loss, Vol. % | 0.5 | 4.5 | 1.5 | 10.0 |
| Incremental Savings for Autofining, $/Year | 305,000 | — | 748,000 | — |
| Payout on Incremental Investment, Years | 1.08 | — | 0.64 | — |

*For further information, technical data, etc., on any refining process, write*

**REFINERY PROCESS DIVISION**

**THE M. W. KELLOGG COMPANY**

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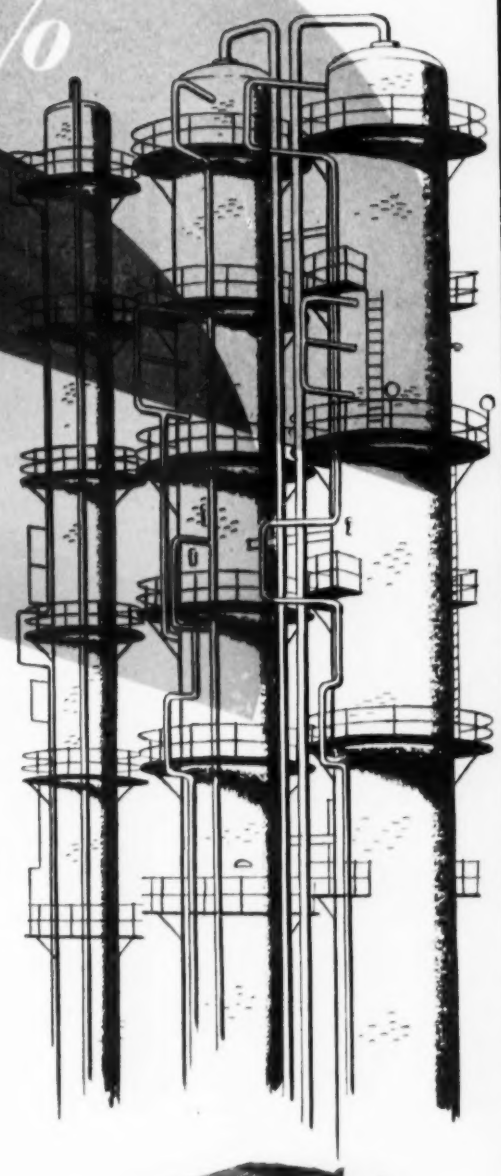
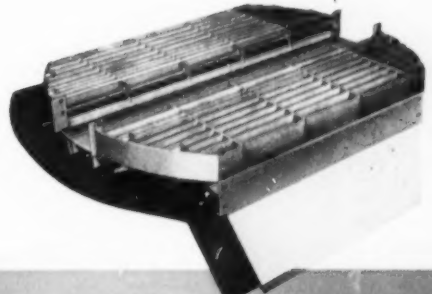


| Design Factors | Bubble Trays | "Benturi" Kaskades |
|---|---|---|
| Low vapor thruput | + | − |
| High vapor thruput | − | + |
| Low liquid thruput | + | − |
| High liquid thruput | − | + |
| Low pressure drop | − | + |
| High pressure drop | + | − |
| High pressure towers | − | + |
| Low pressure towers | + | + |
| Alloy or alloy-clad towers | − | ++ |
| Shop fabricated towers | − | + |
| Field fabricated towers | − | ++ |

Check your requirements on this simple chart. While any one of the "plus" features justify the economy of Koch "Benturi" Kaskade trays, a combination of these conditions provides a "bonanza" to the operator. We'll be glad to give you data on "Benturi" installations to fit your requirements. No obligation.



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# we have never owned an oil well

Certainly oil production is indispensable to our business, nevertheless, Universal has never owned an oil well . . . . never produced any oil . . . never commercially refined, transported or marketed any petroleum products.

Our business . . . . from its very infancy . . . . has been confined to the development and commercial application of petroleum refining facilities . . . . the methods and techniques that have permitted the petroleum refiner

to produce maximum quantities of quality products to meet the demands of his markets.

That we have been successful in this effort is best evidenced by the hundreds of processing units designed by our company, and which are daily serving refineries all over the world.

Universal will never knowingly compete with a petroleum refiner in any phase of his production, refining or marketing business.

In our lifetime we could have acquired many oil wells and perhaps a refinery or two, but we've stuck to our task of helping the refiner . . . . giving him the kind of assistance that he must have if he is to realize a profitable return on his investment.

We Have Never Owned An Oil Well, is a fact that can be further emphasized by saying . . . . we never intend to. We simply won't compete with those we serve.

**UNIVERSAL OIL PRODUCTS COMPANY**

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30 ALGONQUIN ROAD, DES PLAINES, ILL., U.S.A.

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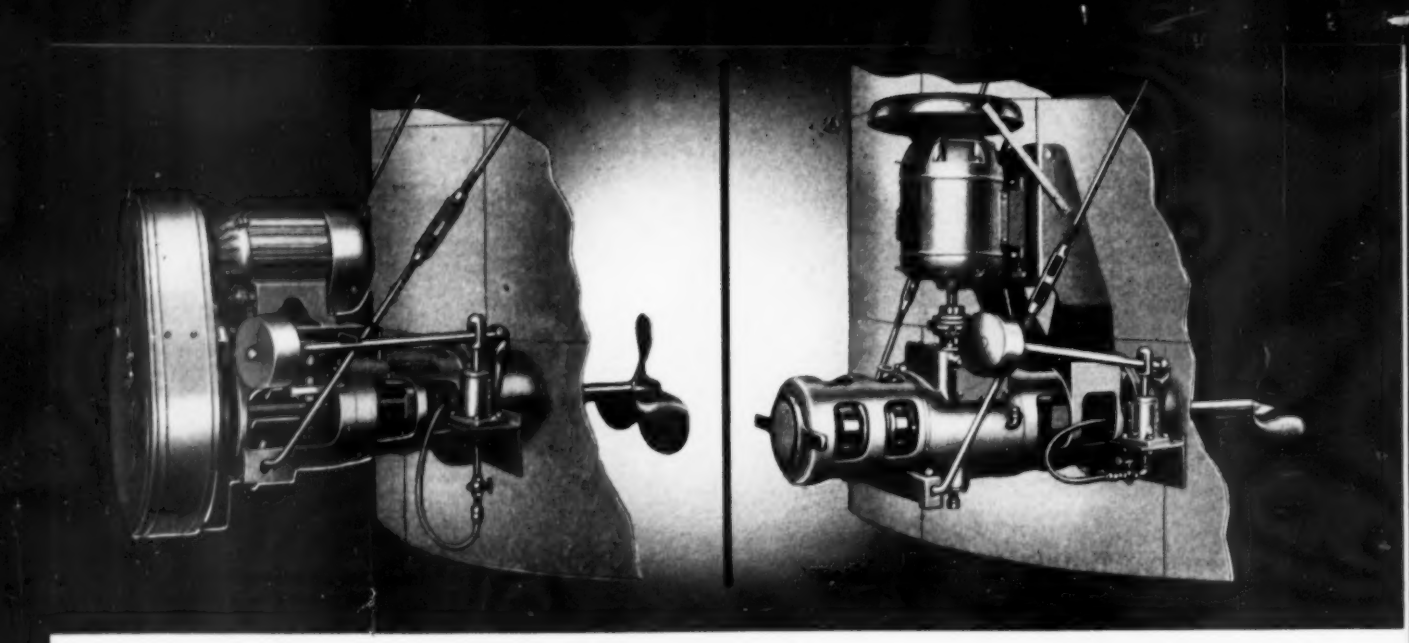
*Universal Service Protects Your Investment*

 *(To obtain more data on advertised products see page 1760)* 



# Which mixer is best for *YOUR* big tanks?

The bigger the tank, the more economical it is to choose mixers closely matched to your needs.

You want just enough power to give you rapid, thorough tank turnover—but no wasted HP.

That's why each of the LIGHTNIN Mixers shown above is supplied in *nine* sizes, from 1 to 25 HP.

Your operating conditions may call for any of *four* standard LIGHTNIN stuffing boxes, or either of two standard mechanical shaft seals. In any case, the type you need is available and has been proved in use.

Years of trouble-free maintenance may depend on your choice of a motor. With LIGHTNIN Mixers, you can choose from *four* standard foot-mounted motor types, *three* standard flange-mounted types, or a wide range of special motors. All are fully guaranteed.

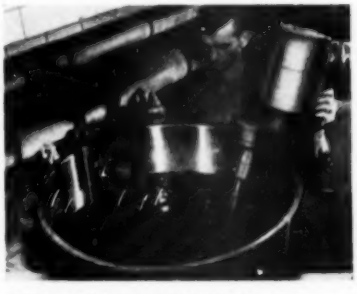
If materials are a problem, you can have the mixer's wetted parts in Carbon Steel, Types 304 and 316 Stainless, Everdur Bronze, Monel, Nickel, Hastelloy B or C, or any other commercially available alloy or metal, and with rubber, lead or other types of covering.

Finally, the LIGHTNIN guarantee protects you two ways: against mechanical failure; against process failure. Every LIGHTNIN is guaranteed to do the job for which it is recommended, or your money back.

If you're thinking about mixing or blending in big tanks, ask your nearby LIGHTNIN man to give you the facts. You can get started *now*, without any obligation, if you call him today.

**EASIEST REPACKING EVER...** with either type, tank shutoff is actuated by turning these easy-to-get-at handles, for repacking with full head of liquid in tank.

**FOR PETROCHEMICAL MIXING** hydrogenations, solids suspensions, high-efficiency stripping operations, LIGHTNIN turbine mixers offer complete adaptability. Sizes 1 to 500 HP.



**FOR CAUSTIC TREATING** feed water treating, preparing specialties, and dozens of other jobs, you can standardize on LIGHTNIN Portable Mixers. Thirty models. Sizes ⅓ to 3 HP.

## "Lightnin® Mixers"

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***In Canada: William & J. G. Greey, Ltd., Toronto 1, Ont.***

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- ☐ B-106 Condensed Catalog (complete line)
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Please send me the catalogs checked at left.

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Company _____

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PETROLEUM PROCESSING
NOVEMBER, 1953

# What Does Corrosion Cost You?

## Refiners' yearly bill is over $220,000,000 for repairs, extra inspections and maintenance, faster depreciation—plus indirect costs from shutdowns, loss of product, fires, accidents

**A STAFF REPORT**
*by the Editors of Petroleum Processing*

THE cost to refiners of having to contend with corrosion of metals in their plants averages 9 cents a barrel of crude oil processed, PETROLEUM PROCESSING estimates following a country-wide survey by its Editorial Staff.

On the volume of crude oil run to stills in 1952, the total estimated direct cost required through handling corrosive substances of many kinds was $219,700,000. This cost is an important factor today in plant operations and even larger in plant maintenance. Because of the complexity of the problem, cost of corrosion in natural gasoline plants and in petrochemical units was not included in PETROLEUM PROCESSING'S study.

Using this average cost figure for straight petroleum refining, the possible direct cost of corrosion to some of the larger oil companies runs into millions annually, and in some cases amounts to 15% or more of their reported net incomes. For a 10,000-barrel refinery, the cost of corrosion, unchecked, could run into the hundred thousands annually. An accompanying table shows the possible, not actual, cost of corrosion to 35 oil companies, based on the estimated general average of 9 cents a barrel of crude processed.

Up to 20% of this direct cost to refiners contending with corrosion—$45,000,000 a year—can be saved by the oil companies, various authorities believe, through the application of methods for corrosion protection now proved to be

For comment on Corrosion, see . . .
***"This Job Calls for Organizing"***
. . . this issue, pg. 1792

***How to Reduce Your Corrosion Losses***

The accompanying article estimating the costs to refiners resulting from the wastage of metals by corrosion is the first in a series. Further articles will show concretely some of the ways in which these losses can be cut down.

Early subjects to be covered will describe the types of organizations and procedures within individual plants and companies which have been found effective in bringing the proper skills and materials to bear on the problem of corrosion damage. They will tell how to correlate data from different plants, how to keep the importance of the fight on corrosion before the plant and company management.

Later articles will discuss some general methods and techniques which can be applied to specific corrosion cases for their more efficient handling.

*If you started to read this story on the front cover, it continues here . . .*

practicable. Appreciating the extent to which these costs can mount, some refineries are intensifying their efforts to reduce the corrosion cost factor through better organization of the required skills and experience in their plants, and through keeping plant managers aware of the seriousness of the problem. They are seeking measures to prevent and control corrosion, rather than to repair the damage after corrosion has occurred.

**The methods being applied** for greater corrosion protection include the use of inhibitors and neutralizers in process streams which are corrosive in character; use of special paints, coatings and linings for vessels, tanks and pipelines; selection of corrosion-resistant materials for parts where corrosion is likely to appear; cathodic protection of buried pipelines and metal structures, and other means.

The estimated direct corrosion cost of 9 cents a barrel includes the following three items:

1—the cost of material and labor for repairs on a processing unit or piece of equipment where corrosion was the cause of the damage.

2—70% of the running maintenance cost of the item assigned to the corrosion factor.

3—an accelerated depreciation allowance for the equipment or unit involved where corrosion shortens the normal anticipated life.

The 9-cent figure does not include the cost of neutralizing chemicals used, cathodic protection for lines, special coatings or linings, or other protective measures of a permanent nature.

Large as is this direct cost factor where applied to the volumes of crude processed in even a small refinery, there are many indirect costs which swell the total figure. These include the loss of production through the enforced shutdown of a unit or piece of equipment, loss of product through leakage or contamination, increased number of inspections required to detect evidence of corrosion, over-design of equipment as a corrosion safeguard, fires and accidents to personnel directly attributable to corrosion, and others.

The nature of these indirect corrosion costs makes it impossible to appraise their cost in relation to the volume of plant operations, as can be done with direct costs. However, many authorities feel that in total they at least equal the direct cost figure. Savings in these indirect costs are achieved when the direct costs are reduced.

In relation to the volume of its operations, corrosion costs in the processing of petroleum are said to mount as high as in any industry. In addition to the atmospheric, under water and underground corrosion, and corrosion due to electrolysis experienced generally, petroleum refining encounters its own special problems in corrosion.

Around 24% of the domestic crude processed, and a much larger proportion of imported crude, contains over 1% by weight of sulfur. Much of the sulfur is in the form of corrosive compounds. Salt water in some crudes also presents special problems. Other corrosion difficulties arise through the acids and sludges used in treating oils with sulfuric acid. High temperature and low temperature operating conditions produce different types of corrosion problems.

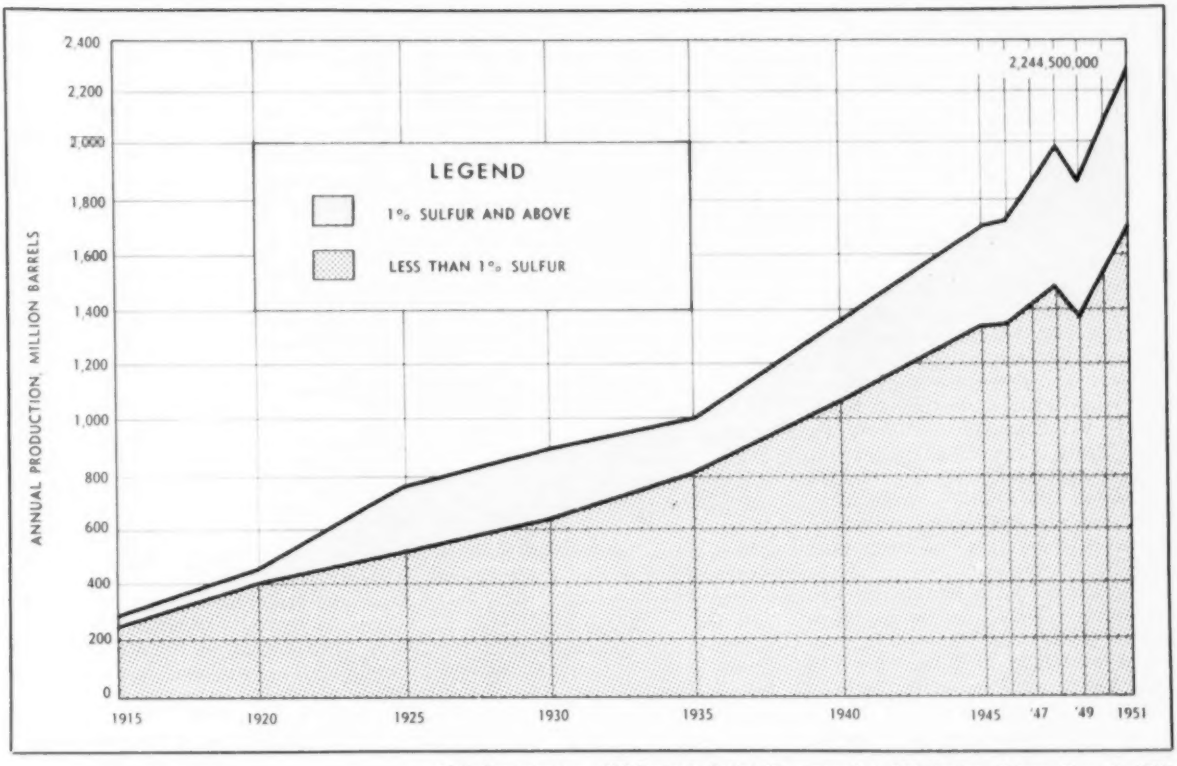
"Of all lines of joint endeavor within the refining industry, the work of corrosion protection and corrosion prevention offers the greatest potential savings to the individual oil companies," stated an official of a large middle west refining company in discussing the subject.

**The wide range of damage** to metals in a refinery which is primarily at-

## *Possible Direct Cost of Corrosion in Refineries for 35 Oil Companies*

| Company | Crude Processed in 1952 (Bbls.) | Possible Refinery Corrosion Cost at 9¢/Bbl. avg. | 1952 Net Earnings |
|---|---|---|---|
| Ashland Oil & Rfg. | 40,153,285 | $ 3,614,000 | $ 14,249,000 |
| Atlantic Rfg. Co. | 64,796,000 | 5,832,000 | 40,427,000 |
| British Amer. Oil Co. Ltd. | 29,355,000 | 2,642,000 | 14,130,000 |
| Cities Service Co. | 80,766,000 | 7,269,000 | 49,259,000 |
| Continental Oil Co. | 34,801,655 | 3,132,000 | 38,087,000 |
| Deep Rock Oil Corp. | 5,650,000 | 509,000 | 904,000 |
| Derby Oil Co. | 3,824,288 | 344,000 | 979,000 |
| Frontier Rfg. Co. | 4,254,711 | 383,000 | 764,000 |
| Gulf Oil Corp. | 182,118,000 | 16,391,000 | 141,820,000 |
| Hancock Oil Co. | 3,807,145 | 343,000 | 3,732,000 |
| Humble Oil & Rfg. Co. | 91,834,000 | 8,265,000 | 145,292,000 |
| Imperial Oil Ltd. | 70,056,744 | 6,305,000 | 41,196,000 |
| Kendall Rfg. Co. | 1,564,390 | 141,000 | 1,107,000 |
| Lion Oil Co. | 7,931,703 | 714,000 | 10,211,000 |
| Mid-Continent Petroleum Corp. | 21,301,193 | 1,917,000 | 15,590,000 |
| Ohio Oil Co. | 13,774,297 | 1,240,000 | 39,354,000 |
| Pan American Petroleum & Transport Co. | 50,696,310 | 4,563,000 | 20,962,000 |
| Panhandle Oil Corp. | 1,977,191 | 178,000 | 877,000 |
| Phillips Petroleum Co. | 79,881,000 | 7,189,000 | 75,284,000 |
| Pure Oil Co. | 37,364,041 | 3,363,000 | 27,304,000 |
| Quaker State Oil Rfg. | 3,026,854 | 272,000 | 1,752,000 |
| Richfield Oil Corp. | 38,383,000 | 3,454,000 | 25,625,000 |
| Shell Oil Co. | 139,632,000 | 12,567,000 | 90,873,000 |
| Sinclair Oil Corp. | 138,987,146 | 12,509,000 | 86,475,000 |
| Skelly Oil Co. | 15,810,850 | 1,423,000 | 28,033,000 |
| Socony-Vacuum Oil Co., Inc. | 222,392,000 | 20,015,000 | 171,092,000 |
| Standard Oil Co. (Cal.) | 148,986,795 | 13,409,000 | 174,030,000 |
| Standard Oil Co. (Indiana) | 185,300,000 | 16,677,000 | 119,980,000 |
| Standard Oil Co. (Ohio) | 43,360,540 | 3,902,000 | 17,697,000 |
| Sun Oil Co. | 78,013,865 | 7,021,000 | 43,013,000 |
| Sunray Oil Corp. | 14,506,969 | 1,306,000 | 24,724,000 |
| The Texas Co. | 192,197,466 | 17,300,000 | 181,242,000 |
| Tide Water Assoc. Oil Co. | 54,947,000 | 4,945,000 | 31,117,000 |
| Union Oil Co. of Calif. | 49,840,000 | 4,486,000 | 27,580,000 |
| Wilcox Oil Co. | 1,522,398 | 137,000 | 769,000 |

Note—There are some duplications in volume of crude processed, through using figures for both parent and subsidiary companies. Operations of foreign plants are included in some cases, where they could not be segregated. Earnings are after all taxes, but are inclusive of miscellaneous income items not derived from operations.




(data from report on API Research Project 48, presented at API Meeting, Chicago, Nov. 10, 1952)

**TREND OF PRODUCTION** of high sulfur content and low sulfur content crude in U.S.

tributable to corrosion was described by G. W. Watts, Director of Engineering, Standard Oil Co. of Indiana, Chicago, before a 1953 meeting of the API Refining Division Committee on Refinery Equipment:

"In the past, the petroleum industry has tended to classify as corrosion only that deterioration of metals which is the result of chemical attack by liquids and vapors. However, the advance of technology in this field now indicates that a different viewpoint may be more logical. According to this new viewpoint, any deterioration of materials in refinery service can properly be considered as corrosion.

"It is true that this definition would include certain phenomena such as erosion, abrasion, creep, fatigue, etc., which strictly are not corrosion. However, in some of the phenomena at least, corrosion still may be a contributing factor even though ordinarily it is not so considered.

"Moreover, such other causes of metal deterioration in the refinery as overheating, with its comcomitant increased tendency toward carburization, decarburization (selective removal of carbon from steel by surface oxidation), scaling (severe surface oxidation), and stress rupture (loss in strength because of selective grain boundary oxidation) are as much characteristic of corrosion as are the more commonly thought of hydrogen sulfide, sulfur compound, or hydrogen types of attack."

**Men in charge** of corrosion prevention work in many oil companies and refineries over the country were interviewed in the PETROLEUM PROCESSING staff survey of corrosion costs. Also conferred with was Frank N. Speller, of Pittsburgh, well known authority on the subject of corrosion in industrial plants. A survey of refinery corrosion costs made by the API Refining Division in 1927, under the direction of Dr. Speller, was studied and these earlier figures related to refinery operating conditions today insofar as possible.

By coincidence, a group of the Subcommittee on Corrosion of the Committee on Refinery Equipment of the API Refining Division, has also been making a study of direct refinery corrosion costs, over the past several months. F. C. Braun, Engineering Dept., Gulf Oil Corp., Pittsburgh, is chairman of the group. Its work is not completed, and will be reported later, but it is understood that the 9-cent-a-barrel estimate of PETROLEUM PROCESSING is conservative as compared with the preliminary work of the API corrosion cost group.

**The 1927 study of corrosion** made by Dr. Speller and his associate, E. L. Chappell, both then with National Tube Co., included all branches of the industry. Fourten oil companies, with a crude charging capacity of 592,900 bbls. daily, took part in the setting up of corrosion costs in refineries. Only direct costs were given and these included maintenance, lost time and depreciation. Aside from the lost time factor, which was not a large cost item, the method of estimating the loss figure in 1927 is about the same as that followed by PETROLEUM PROCESSING and the group of the API Refining Division Committee on Refining Equipment in their current studies.

There was considerable variance in the returns from the individual companies in the Speller survey. The total yearly refinery corrosion cost arrived at for 1927 was $8,447,200 for the 592,900 total charge capacity of the plants of the 14 refining companies reporting. The average annual unit

cost reported in $/yr/1000 b/d capacity was $16,700.

On the basis of these returns, the annual total direct corrosion cost in all U. S. refineries in 1927, with charging capacity of 2,850,000 b/d, was $47,700,000. The average annual 1927 corrosion cost on the basis of $/yr/1000 b/d capacity, resolves itself into about 4.6 cents per barrel of crude processed.

Since 1927, many factors have worked both to increase and to lower the unit cost of corrosion. Probably that with the most bearing is the large increase in maintenance costs. Industrial construction costs (materials and labor) have increased 2.9 times the 1927 figure.

**Also important** is the fact that the volume of crude likely to bring corrosion problems and being processed in refineries today has increased since 1927.

The data in the accompanying chart show the volume of crude produced in the U. S. since 1915 with 1% or more by weight of sulfur, and that with less than 1% of sulfur. In 1951, production of the so-called "sour" crudes was 24% of the total domestic production of 2,244,500,000 bbls. Corrosion, however, is not a function of the percentage of sulfur in crude, but rather of the nature of the sulfur compounds present. Some crude with less than 1% of sulfur present serious corrosion problems.

For the future, the extent to which high sulfur crudes will be processed depends on where the major crude sources are developed for U. S. refineries. If we continue to import large volumes of Middle East crude, virtually all of this crude has a sulfur content in excess of 1%. South American crudes for the most part contain a high percentage of sulfur, and most of the large producing fields are in this category. If sources of crude are developed further in this country, such as the Williston and Julesburg Basins, there the crude will average under 1% by weight of sulfur. A majority of the new fields in Canada produce crude under 1% by weight of sulfur.

**Changes in operating conditions** influencing corrosion in refineries, since the previous all-industry study was made in 1927, were reviewed for PETROLEUM PROCESSING by F. L. LaQue, in charge of the Corrosion Engineering Section, International Nickel Co., New York.

"Since 1927, when the first estimate was made," he stated, "there have been many changes in petroleum refining operations which would influence the incidence and cost of corrosion. In the first place, refining processes have become more complex and are being carried out under much more stringent conditions with respect to temperatures, pressures, velocities and the like.

"Next, the crudes being processed have, I believe, on the average increased in their corrosivity due to the presence of higher sulfur contents. They contain at least as much salt and special corrosive constituents, such as naphthenic acids, vanadium oxides and the like.

"Thirdly, the equipment itself has become more complex and has increased in the amount of capital investment required, partly by reason of the more extensive use of corrosion-resistant materials. This would show up in the annual carrying charges which presumably could be debited against corrosion which has made them necessary.

"Added to all this are the higher costs of installation labor and maintenance labor when this has been required.

"To offset these items on the debit side, we can certainly credit the greater use of corrosion-resistant materials with a substantial improvement in the useful life of the equipment, fewer shutdowns on account of corrosion failures with consequent lowering of maintenance costs, and with reduction of losses which result from interruptions of production. To this can presumably be added the lessening of losses due to explosions and other hazards which are avoided by the elimination or reduction of failures due to corrosion.

"If we assume that the 1927 figure on corrosion losses in refineries was anywhere near correct and having in mind the greatly increased capacity of refineries as a result of the introduction of new processes and equipment, an examination of the figures would probably lead to the intuitive conclusion that the cost of corrosion in terms related to the volume of operations must have been considerably reduced during the past 25 years."

Mr. LaQue was one of the few men interviewed who thought the corrosion rate had been lowered.

**On the low side** on estimated corrosion losses in U. S. refineries is a figure of $50,000,000 included in a report on total corrosion losses of all kinds in this country, which was made by Herbert H. Uhlig, Associate Professor, Corrosion Laboratory, Department of Metallurgy, Massachusetts Institute of Technology, before the Scientific Conference on the Conservation and Utilization of Resources of the United Nations, in 1949 at Lake Success, N. Y. This figure was for "oil refinery maintenance." Prof. Uhlig said it should be corrected to include that portion of the cost of corrosion-resistant materials, such as paints, coatings, alloys and special metals which was above the cost of materials that would normally be used. This would increase his original estimate materially.

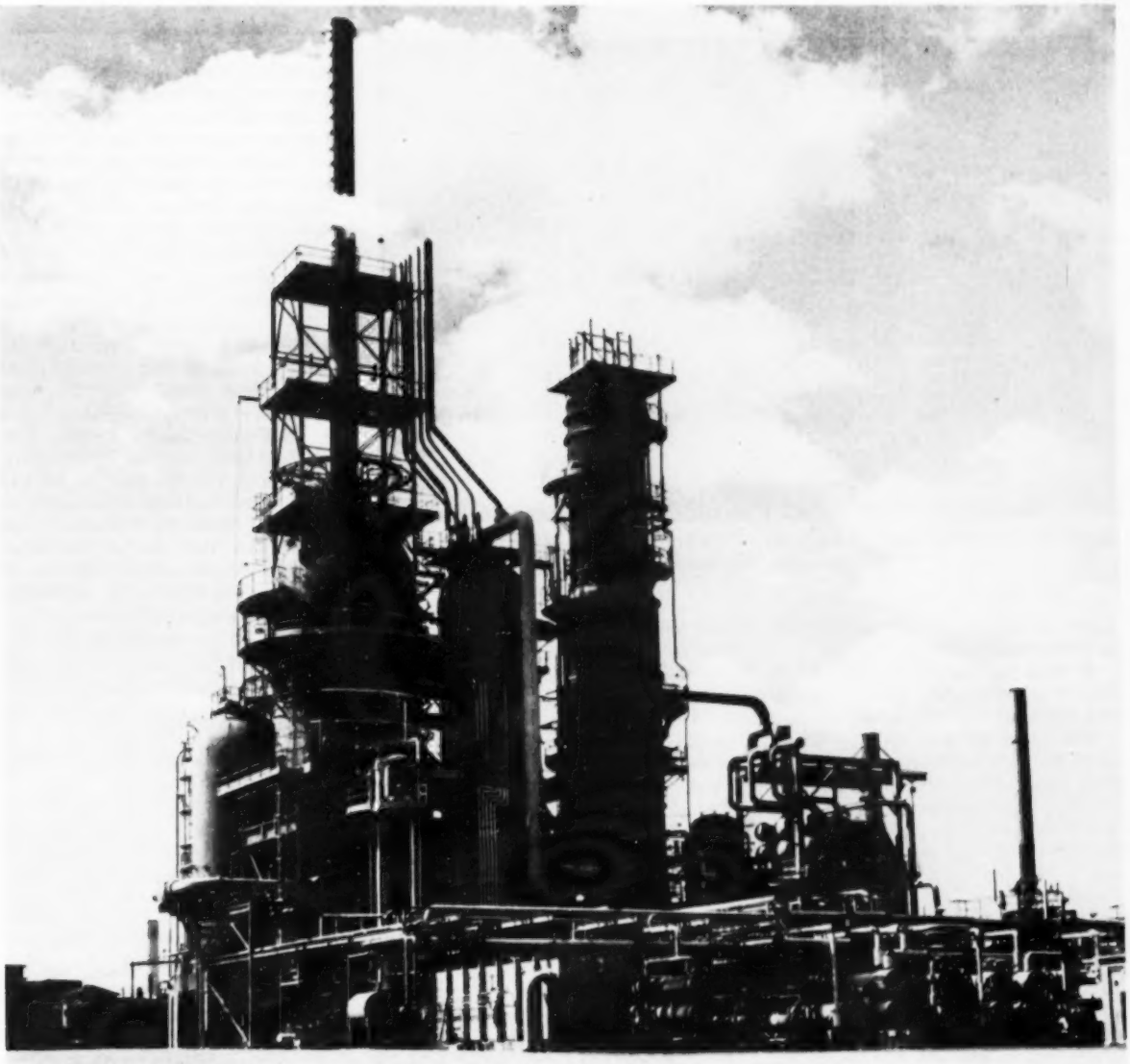
**Considerable difference of opinion** undeniably exists among oil company technologists and outside authorities as to the extent of the actual direct loss to refineries through corrosion of metals.

The 9-cent-a-barrel estimate by PETROLEUM PROCESSING was based on information coming to its staff from several sources. This figure may be controvertible. Whatever amount is accepted, this journal will feel its study has been constructive if the point is brought home to the oil companies that their corrosion losses are large and that means are available to reduce them substantially.

## Cost Surveys First Step in Cutting Losses

"The present studies of the cost of corrosion in refining should reveal the extent of these losses and provide for management's determining how much can profitably be spent to reduce them," Frank N. Speller, corrosion consultant, Pittsburgh, told PETROLEUM PROCESSING. Dr. Speller conducted the earlier 1927 study of corrosion losses in the oil industry sponsored by the API. "The survey in 1927 indicated a waste that would have cut seriously into profits if it had not been reduced. At present the aggregate loss from this cause is still very high, due to the increased volume of operations and higher maintenance costs.

"Competent corrosion engineers are investments in the long-time value of refineries. Means of prevention are now better understood but new problems are continually coming up requiring research. It is estimated that 50 to 75% of cost of maintenance in refineries is due to corrosion. Undoubtedly much of this can be prevented."



**LATEST DESIGN** of the "Model IV" Fluid catalytic cracking unit is first to be built at Everett, Mass., and . . .

# First Cat Cracker in New England

## Esso's new Fluid unit uses 30% less steel, only one expansion joint, and no slide valves

THE new 24,000 b/d Fluid catalytic cracking unit at Esso Standard Oil Co.'s Everett, Mass., refinery, onstream since July 15, and dedicated October 15, was designed for the optimum in investment and maintenance costs. Among a number of features of interest to refiners in this new unit—the latest Model IV design—are:

1. Control of catalyst circulation rate is effected by varying the density in the transfer line, eliminating the need for slide valves for throttling and thus reducing costs.

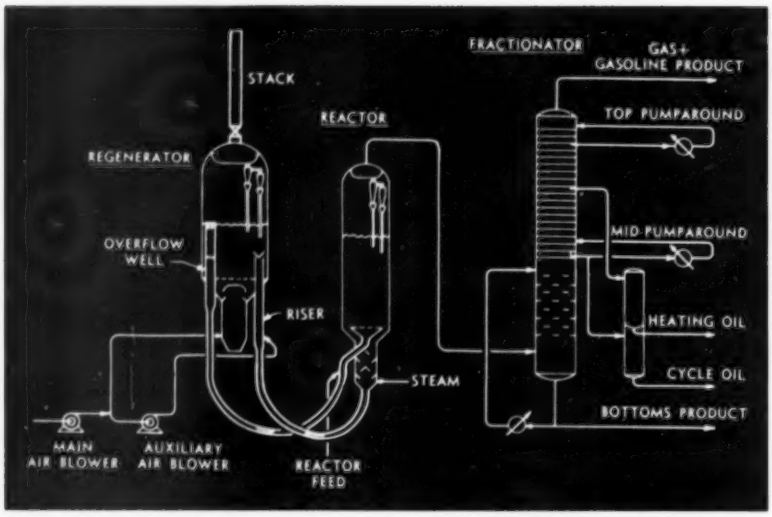
2. Less equipment is required for catalyst separation.

Unit uses only two-stage cyclones, both in the reactor and regenerator.

3. Only one expansion joint is used in the entire unit.

4. The auxiliary burner has been attached directly to the bottom of the regenerator.

5. Complete unit utilizes about 30% less steel than would have been required under earlier designs. A Model IV less than 100 ft. high has the




**SLIDE VALVE ELIMINATION** by using air to control circulation is illustrated in this simplified flow diagram

same capacity as earlier designs 140 ft. or more in height.

6. Both the compressor and the air blower are electrically driven, permitting optimum use of existing utilities.

The new unit—first catalytic cracker to be built at Everett and first in New England—is only part of an overall plant modernization and expansion, which included: light ends demethanizing, absorbing and debutanizing towers; a naphtha splitter, a rerun unit; revamped crude still, product finishing facilities, and the future provision for vacuum flashing.

**An unusual procedure** in the construction program was a two-month shut-down (except for asphalt facilities) to allow the new units to be finished, tied in, and put into operation. This plan was decided upon because it was found more economic in the long run to get into production as fast as possible on the manufacture of high octane gasolines.

With only a 15,000 b/d thermal cracking unit in operation before the modernization project, Esso was not producing any premium grade motor fuel at Everett. With the new facilities, the plant crude capacity has been raised from approximately 32,500 to 45,000 b/d. The refinery has now become self-sufficient in the production of gasoline. Heretofore, Everett had to bring in components from other plants to make premium grade gasoline.

The Model IV design is the fourth major improvement in the redesign of the original Fluid catalytic cracking unit built in 1942. Since that time, Standard Oil Development Co. has been eliminating operating bottlenecks and streamlining the equipment to cut costs and improve the unit service factor. The first Model IV, an 11,000 b/d unit, went on stream last fall at the Edmonton, Alberta, refinery of Imperial Oil, Ltd. Design data for the new Everett unit are given in Table 1.

**One of the most important improvements** incorporated in the new design is the separation of gas and catlyst in reactor and regenerator (see flow diagram). Originally, the oil vapors and catalyst both passed overhead from the reactor and were separated in a series of multi-cones, cyclones, hoppers, and large lines outside of the reactor vessel. Enough catalyst was carried into the fractionator to require an elaborate oil-catalyst separating system—called the slurry system—to clean up the fractionator bottoms. In subsequent models, this equipment has been considerably reduced.

In the new unit, highly efficient, two-stage cyclones suspended from the top of the reactor have eliminated all other catalyst recovery equipment, including the slurry system.

On the regenerator side, a similar elaborate catalyst recovery system, including a Cottrell precipitator, was required to produce a clean flue gas. Now, two-stage cyclones in the regenerator, without any other equipment, produce a cleaner flue gas with fewer operating problems. The new system also represents an obviously large saving in capital investment.

**Another major advance** has been the elimination of slide valve control of the catalyst circulation between reactor and regenerator. In previous units, bulky and expensive slide valves —sometimes even in triplicate—were used to control the flow of spent and regenerated catalyst at rates up to 60 tons/min. These valves erode gradually and control of the unit eventually becomes difficult. The erosion rate has determined the onstream time on the earlier models.

Slide valves on the Model IV remain wide open during operation: they are used only for start-up and shut-down, or emergencies, thereby eliminating the factor of erosion. Catalyst circulation rate is controlled through two U-bends by varying the density of the stream of catalyst in part of the transfer line, through aeration.

Spent catalyst drops from the reactor thro.gh a catalyst stripper into one of the U-bends, where it has a density of 45 lb./cu.ft. Over on the regener-

## Table 1—Design Data, Catalytic Cracking Section

| | |
|---|---|
| **Reactor Conditions:** | |
| Dense bed temperature, °F. | 900 |
| Pressure, psig. | 9.0 |
| Catalyst/oil ratio, lbs./lbs. | 6.45 |
| Catalyst circulation rate, tons/min. | 17.5 |
| Catalyst holdup (above grid), tons | 25-70 |
| Total feed rate b/d | 24,000 |
| % recycle on total feed, vol.-% | 37 |
| Total feed gravity, °API | 21.5 |
| Conversion on fresh feed, Vol.-% | 65.2 |
| **Regenerator Conditions:** | |
| Dense bed temperature, °F. | 1125 |
| Pressure, psig. | 9.0 |
| Holdup, tons | 90.0 |
| Carbon burning rate, lbs./hr. | 13,000 |
| Air Rate (dry), SCFM | 38,000 |
| **Gasoline Quality:** | |
| CFRR octane number, clear | 94.1 |

ator side of the U-bend, a riser passes upward into the regenerator vessel. A controlled air stream is injected upwardly inside of this riser, which drops the catalyst density to about 20 lb./cu.ft. This differential in head between the two fluid phases of catalyst in the U-bend forces the flow in the direction of the regenerator.

Leaving the regenerator, the catalyst flows over a weir which maintains a constant hold-up in the vessel. Catalyst then flows through the return U-bend. In the reactor riser, the gas oil feed vaporizes on contact with the hot regenerated catalyst, and thus lowers the density, and pressure, in the riser. The pressure head in the overflow well is sufficient to push the catalyst into the reactor.

**Since the slide valves are eliminated** as a control device, the hydraulic system which motivates them is also eliminated. The remote controlled valves on the Everett Model IV are all air-motor actuated.

Elimination of the throttling slide valves also makes the unit easier to operate and more stable in operation, according to Standard Oil Development Co. engineers. With all controls grouped at a single level near the ground, the Model IV requires less operating personnel than was needed for previous Fluid catalytic cracking units. At Everett, a total of three or four men per shift is needed as against the usual six to seven on older units.

**Regarding operational stability,** S.O.D. engineers state that "reverse flow" is far less likely to occur with the new unit than with any previous designs. With the new circulation system, a serious pressure differential between reactor and regenerator will cause the fluidized catalyst to "defluidize" and form an effective temporary "seal." As soon as the pressures in the vessels are in balance again, the catalyst "re-fluidizes" of its own accord, restoring normal circulation.

**Only one expansion joint** is used on the unit, despite the fact that temperatures over 1100° F. will exist. The elimination of long and numerous hot transfer lines and the use of the suspended U-bends has greatly reduced the need for this expensive and troublesome equipment.

The device used to warm up the unit at start-up is called the auxiliary burner. In the past this has been housed in a separate vessel and required large air lines and bypasses to tie into the regenerator. However, in the Model IV, the spent catalyst U-bend sends the catalyst directly into the regenerator above the grid. This makes it possible to pipe the main air stream directly through the auxiliary burner into the regenerator. Therefore, the auxiliary burner is attached directly to the bottom of the regenerator to simplify the design and save money.

Both the gas compressor and the main air blower are driven by electric motors (3500 hp in the air blower), the largest electric motors in the refinery.

Including a hot catalyst storage hopper has eliminated the need for the usual catalyst worm coolers which have tended to plug on occasion on some earlier units. Reactor hold-up can be changed only by adding or withdrawing catalyst from the unit, which requires frequent use of the hot hopper facility.

With start-up of the major portion of the new refinery units set for close synchronization, it was deemed wise to schedule the two-month shutdown mentioned earlier.

**The long turnaround** was used to a distinct advantage in training Everett personnel to handle the new units, with which many were unfamiliar. The complete training program included some preliminary work prior to the actual turnaround. Trainees included process operating personnel, night superintendents, 1st class instrument men, engineers from the operations analysis department, and management.

Night superintendents received all their training before the actual shutdown at Everett. First, they took a general orientation course based on the operating manual for the new units, and consisting of five two-hour sessions in the classroom, every other afternoon. Secondly, they were given contact training in the field in three-day sessions, at the company's Baltimore and Bayway refineries.

Process operators received a general course first, consisting of five eight-hour sessions. This was followed by a two-week program of classroom work studying the principles and operations of the Everett units. Actual contact training for operators took place during the long turnaround. One-third of the group trained at Baltimore and two-thirds at Bayway; stillmen received a two-week course and helpers a one-week course.

During the period that the operators were away from Everett, the manage ent and operations analysis department groups attended classes for two hours every day over a two-week period. The operations analysis personnel then went on to a two-week program of contact training at Bayway.

Meanwhile, following the sessions for stillmen and helpers, groups from the poly plant, thermal cracking unit, and gas absorption/compression units took classroom and field training for one-week periods.

**Last to receive programs** of instruction were the operating personnel and instrument men from the catalytic cracking unit. For a period of six weeks, they received intensive on-the-job training on a full schedule every day. Mornings were devoted to classroom work with lectures, demonstrations, blackboard work, and quizzes. Afternoon, stillmen coached their respective operating teams at the units, with the assistance of process department heads. All operators were then assigned to their regular shifts at the time of start-up.

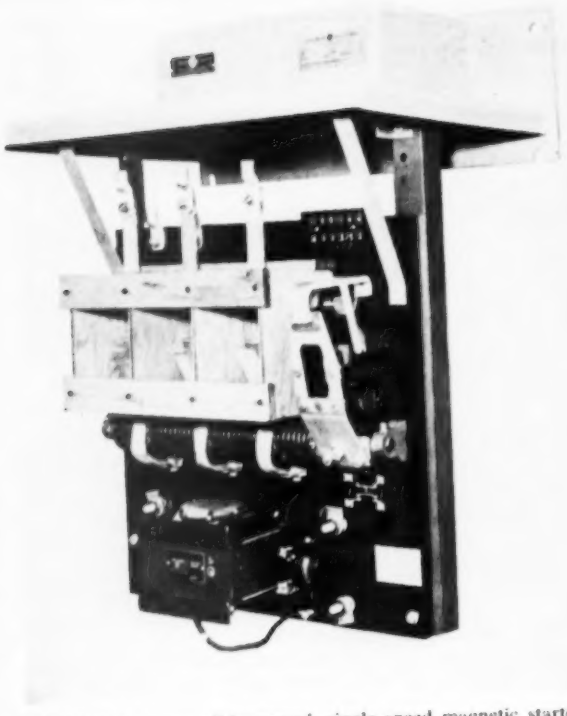
The Model IV unit is covered by patents owned by Standard Oil Development Co., and S.O.D. is making this new type unit available to the petroleum industry under license. Foster-Wheeler Co. was the contractor for the 24,000 b/d unit at Everett. Chicago Bridge & Iron Co. built the vessels in the modernization program.

There are some 20 Model IV units in various stages of construction or in operation throughout the world. When completed, they will have a combined total throughput of about 295,000 b/d.

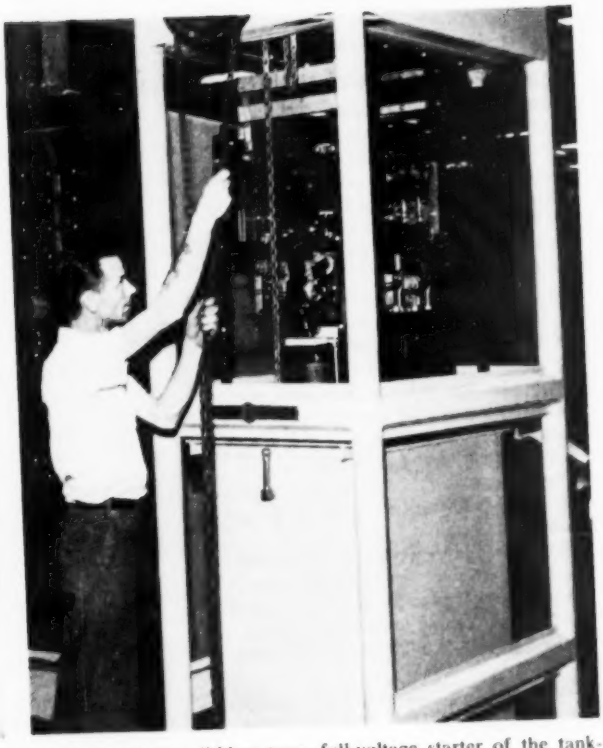
## *Esso Spending $23,000,000 in New England*

Modernization of the Everett refinery is a part of more than $23,000,000 Esso has spent or earmarked in the last five years for new and improved manufacturing and marketing facilities throughout New England. Among these are two million-bbl. storage terminals nearing completion in New Haven, Conn., and Waltham, Mass.

Crude oil throughput at Everett has been raised from 38,000 to 50,000 b/d. In addition to the cracking unit, other new facilities include a 7,000 b/d re-run pipestill, and new light ends units. Process design and equipment specifications for the new cracking unit and the revamping of existing units were completed by Standard Oil Development Co. Process units were constructed by Foster Wheeler Corp.



**EQUIPMENT A**—an oil-immersed, single speed magnetic starter (shown with tank removed)

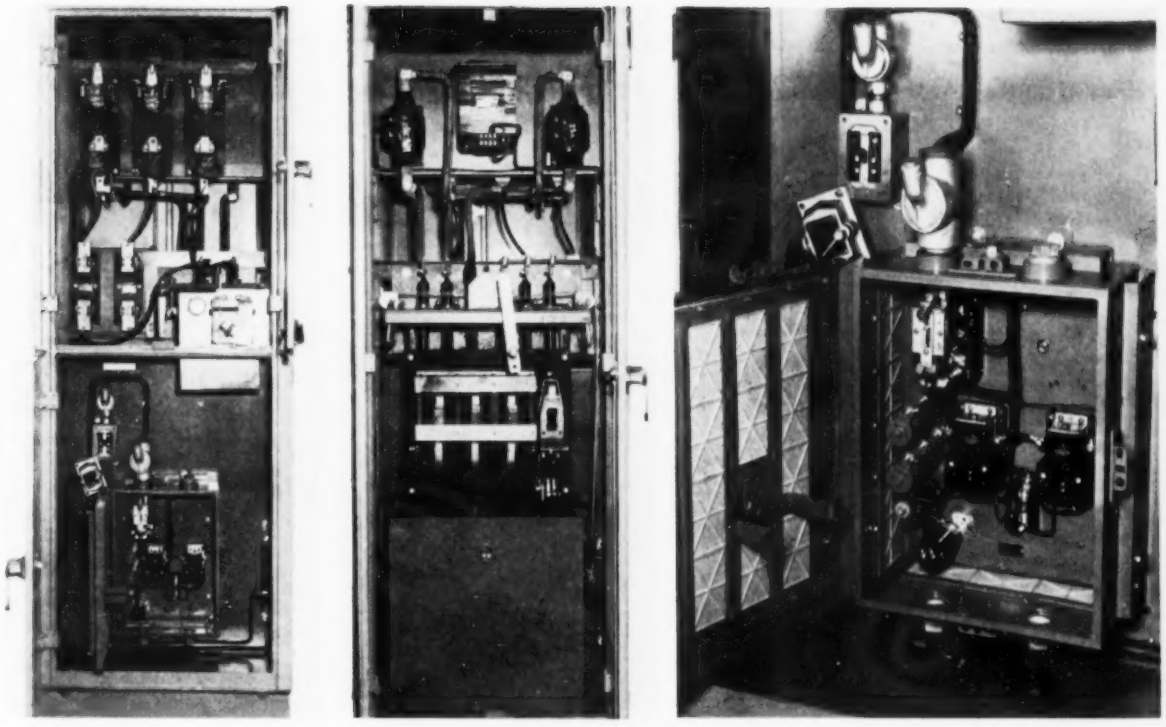


**EQUIPMENT B**—oil-blast type, full-voltage starter of the tank-lowering type

# Electric Motor Controls . . .

**EQUIPMENT C**—a line-up of magnetic controllers of the so-called "limitamp" type

**EQUIPMENT D**—Outdoor metal-clad switchgear, used for both motor starting and distribution feeding



**EQUIPMENT E**—current-limiting type with arcing contacts protected, front view at left; rear view at center; close-up of low-voltage box at right

# How to Pick One for Your Plant

***By L. T. ELLIS and A. L. R. MAYNARD***
***General Electric Co., Philadelphia***

IN setting up a suggested evaluation means for measuring the effectiveness of the various 2300- and 4160-volt motor control equipments available to meet the problems of the petroleum refining industry, a most important tool is a "yardstick."

The first mark on such a measuring stick should be to consider the adaptability of the equipment to the hazardous atmospheric conditions usually encountered in the refinery. Point 1 should then be: adaptability of the equipment to Class I, Group D, Division 2 requirements.

Secondly, the corrosive atmosphere of the refinery challenges the application of motor control apparatus. In addition, there are eight more application problems to be considered as measuring points in the "yardstick":

3—First cost.

4—Installation cost.

5—Maintenance expense.

6—Range of interrupting capacity available.

7—Suitability for outdoor application.

8—Completeness of the starting equipment in one structure.

9—Diversity of use.

10—Horsepower control range available.

**Why consider only these two voltage** levels—2300 and 4160 volts, 3 phase, 60 cycles? The use of electric power in refining has increased at a fantastic rate during the past 20 years—from one KWH/bbl. of charge to four KWH/bbl. today. Correspondingly, there has been a growth in the problems of energy control at all levels. However, the industry has found it necessary to provide ever larger motors, more reliable systems, and circuit arrangements with greater inherent flexibility.

This has meant a trend into the higher voltage levels and the need for apparatus with higher and higher "interrupting capacity." And today, fortunately, there is available a wide range of control apparatus in the 2300- and 4160-volt ranges.

Is the 10-point yardstick a good measuring means? Based on our own experience, we believe it will serve as a reasonable estimate. In petroleum refining there are many other associated application problems. We would suggest, in formulating an evaluation of your own, that any other factors considered of great importance be included.

**How does the yardstick work?** The equipments available must be examined and measured with this gage. For reference purposes, they will be designated as Equipments A, B, C, D, and E.

**EQUIPMENT A** is an oil-immersed, magnetic starter, non-reversing, single speed, for 2300 volts, 3-phase, 60-cycle service. The maximum rating of the starter shown in the photograph is 350 hp. at 2300 volts. This same general type is available up to approximately 700 hp. at 2300 volts and 1250 hp. at 4160 volts. This equipment has an interrupting rating of only 10 times the normal current rating of the motor to which it is applied.

The starter consists essentially of an oil-immersed line contactor, current transformers of suitable ratio, thermal induction temperature over-

## Table 1—Yardstick for Evaluating Equipment Applications

| Factor | Equipment Designation | | | | |
|---|---|---|---|---|---|
| | A | B | C | D | E |
| 1—Class I, Group D, Div. 2, hazardous area | 5 | 5 | 0 | 0 | 5 |
| 2—Corrosive atmosphere | 5 | 5 | 5* | 5* | 5* |
| 3—First cost | 5 | 4 | 3 | 1 | 2 |
| 4—Installation cost | 2 | 1 | 5 | 4 | 5 |
| 5—Maintenance and associated costs | 5 | 2 | 4 | 5 | 4 |
| 6—Range of interrupting capacity available | 0 | 3 | 5 | 5 | 5 |
| 7—Suitable for outdoor application | 5 | 5 | 5 | 5 | 5 |
| 8—Relative completeness of starter in one structure | 1 | 1 | 5 | 5 | 5 |
| 9—Diversity of use—easily adapted to changes | 2 | 2 | 4 | 5 | 3 |
| 10—Range of horsepower | 3 | 3 | 4 | 5 | 2 |
| Total relative scores | 33 | 31 | 40 | 40 | 41 |

* With space heaters and proper outside hardware and finish.

load relays, and a 2300-volt/230-volt control power transformer. A separate disconnecting means is required.

**EQUIPMENT B,** one type of which is shown in the photograph, is an "oil-blast" type of motor starter, and has an interrupting capacity of 50,000 kva. It is fully oil-immersed, full-voltage, non-reversing, magnetic; and is suitable for application up to 700 hp. maximum at 2300 volts and 1250 hp. at 4160 volts. It is NEMA Class E1.

The starter consists essentially of a latched-in contactor, a control transformer, suitable current transformers, thermal induction overload relays, and instantaneous trip relays, for short-circuit protection. A separate disconnecting means is required.

The unit illustrated is a tank-lowering type. A refinery installation will usually require a battery of perhaps five starters, which, because of the large oil tank and heavy weight, will require an overhead crane for servicing.

**EQUIPMENT C** is the so-called "limitamp" magnetic controller, a "line-up" of which is shown in the photograph. The maximum rating available in the standard general-purpose type of equipment is approximately 1250 hp. at 2300 volts and 2250 hp. at 4160 volts. This equipment has current-limiting-type fuses which give it a short-circuit interrupting rating of 150,000 kva at 2300 volts, 3-phase, 60 cycles, or 250,000 kva at 4160 volts. It is NEMA Class E2.

Each starter consists essentially of three current-limiting fuses, an oil-immersed or air-break high-voltage contactor, suitable current transformers, ambient compensated thermal induction overload relays, a time delay undervoltage relay, control circuit transformer with two current-limiting fuses, and other miscellaneous control devices normally required.

**EQUIPMENT D** is outdoor metal-clad switchgear. Often used for motor starting, it can also be used for distribution feeder service. The apparatus is available for full-voltage and reduced-voltage service for both induction and synchronous motors. The basic equipment is available in industry standard voltage ratings to 13,800 volts.

The 2300-volt switchgear starting equipment is adaptable, with very slight modification, for 4160-volt service. Maximum continuous current rating is 1200 amps. This equipment includes a range of interrupting capacity ratings extending to 150,000 kva at 2300 volts and 250,000 kva at 4160 volts.

A basic switchgear-type motor-starting unit for a full-voltage start application with a squirrel cage induction motor would include insulated bus, suitable current transformers, removable type air or oil circuit breaker, cable terminating facilities, instantaneous overcurrent relays, thermal overload relays for motor protection, instrumentation, and control circuit components.

All of these devices are contained in one self-supporting metal-enclosed structure compartmented into various functional sections. Individual equipments of this type are very often grouped into large sections for controlling many important motor circuits. The equipment can be, and very often is, combined with transformers to form "unit substation" type equipments.

**EQUIPMENT E** is essentially the same as the standard "limitamp" equipment designated **C,** except that it has the additional protection afforded by having all arcing contacts either oil-immersed or located in an air-break explosion-proof housing, or so interlocked that they cannot be opened under any load whatsoever, including the magnetizing current of the control transformer.

This equipment meets fully the intent of Underwriters' Class I, Group D, Division 2, explosive area classification. The Underwriters' standards for control equipment for hazardous locations are intended to apply only at 600 volts or lower.

**How do these five equipments shape up** on a rating scale when applied to the 10-point yardstick? Table 1 summarizes this information and permits conclusions to be drawn for a more intelligent selection of motor control equipment. For purposes of evaluation, a scale has been selected arbitrarily from 0 to 5, with 5 being high. Individual plant engineers might wish to include more or less than the 10 points being used in this yardstick. Or, it might be desirable to weight each point differently—based upon individual application requirements and plant experience. The method shown in Table 1 is only a suggestion. It should not be considered the final answer under a given set of conditions.

If a zero appears opposite a feature which is of importance in evaluating equipment under a given set of conditions, then the equipment under which the zero appears should be eliminated. The equipment would not be acceptable.

**For example:** if an equipment must be suitable for location in a hazardous Class I, Group D, Division 2 atmosphere, then Equipments **C** and **D** should be eliminated.

Also; if equipment is required with 100,000-kva interrupting capacity, any equipment with less than 100,000 would logically measure zero under that set of conditions. Suppose that a 50,000-kva interrupting capacity starter is adequate at the time the evaluation is made. It might be well to consider an equipment with more than 50,000 and give it a higher comparative rating—realizing that distribution systems grow. It is entirely possible that something more than 50,000 kva will be needed in the future to meet greater demands in a larger plant.

All of these qualifications confirm our conviction that attempting an evaluation of this type is a difficult task. However, this table appears to be a reasonable approach to the problem. No yardstick is useful unless intelligently handled.

With this approach, the equipment which ends up with the highest total score should be the equipment for first consideration. In the case of the hypothetical petroleum industry situa-

tion considered, Equipment **E** seems most adaptable.

An intelligent job of evaluation obviously requires all possible information about the equipment available. Equipments **A, B, C,** and **D** are types which have been available for years with no radical design changes. It is hoped that the brief descriptions have served their purpose.

On the other hand, much less is known generally about Equipment **E.** It has just recently undergone several changes to make it even more adaptable to the challenge of use in the petroleum industry. Reference is made to the three photographs illustrating this equipment.

In the front view with the door open, near the top are three sets of supports for the high-voltage, high-interrupting-capacity, current-limiting fuses. Just below and to the left are the supports for the high-voltage fuses for the primary of the control transformer. To the right of this set of fuses is the high-voltage control transformer disconnecting switch. This high-voltage compartment has a separate door.

The low-voltage compartment is located near the bottom of the unit. The equipment in this section consists essentially of an explosion-proof box containing the ambient compensated thermal induction overload relays, the time-delay undervoltage relay, and the low-voltage, current-limiting fuse for the secondary of the control transformer. This novel, explosion-proof enclosure is a radical departure from the conventional bulky, heavy, cast-iron box used for this application. It is shown in somewhat greater detail in the close-up view.

The enclosure is constructed using the Davey Miner's lamp principle. Inserts of sintered material are porous enough to allow the escape of gases. This accomplishes two things: 1) it relieves the pressure within the box, and 2) it cools the gases to a temperature level that will not set off an explosion outside the enclosure. The box has been tested by the Underwriters' Laboratories, and it has been determined that it will operate successfully with 75% of the openings in the porous inserts plugged.

The back view of the starter shows the control circuit transformer located near the top; with the two current transformers beside it. The oil-immersed contactor is near the bottom: it is shown with the tank lowered.

Fig. 1 shows a schematic diagram of the electrical circuit of a typical "refinery-type" induction-motor starter. The power circuit includes high-interrupting-capacity disconnect-type current-limiting fuses. Power flows through these fuses and through the oil-immersed high-voltage contactor, and then to the motor terminals. The high-voltage contactor, designated as **M,** is a magnetic motor-starting device. The contacts on this device make and interrupt the normal motor currents. These contacts are located at least 6 in. under oil. Thus, this contactor satisfactorily meets the requirements of a Class I, Group D, Division 2 atmosphere.

Under short-circuit conditions, the fuses interrupt the fault current. The fuses are also constructed to satisfy

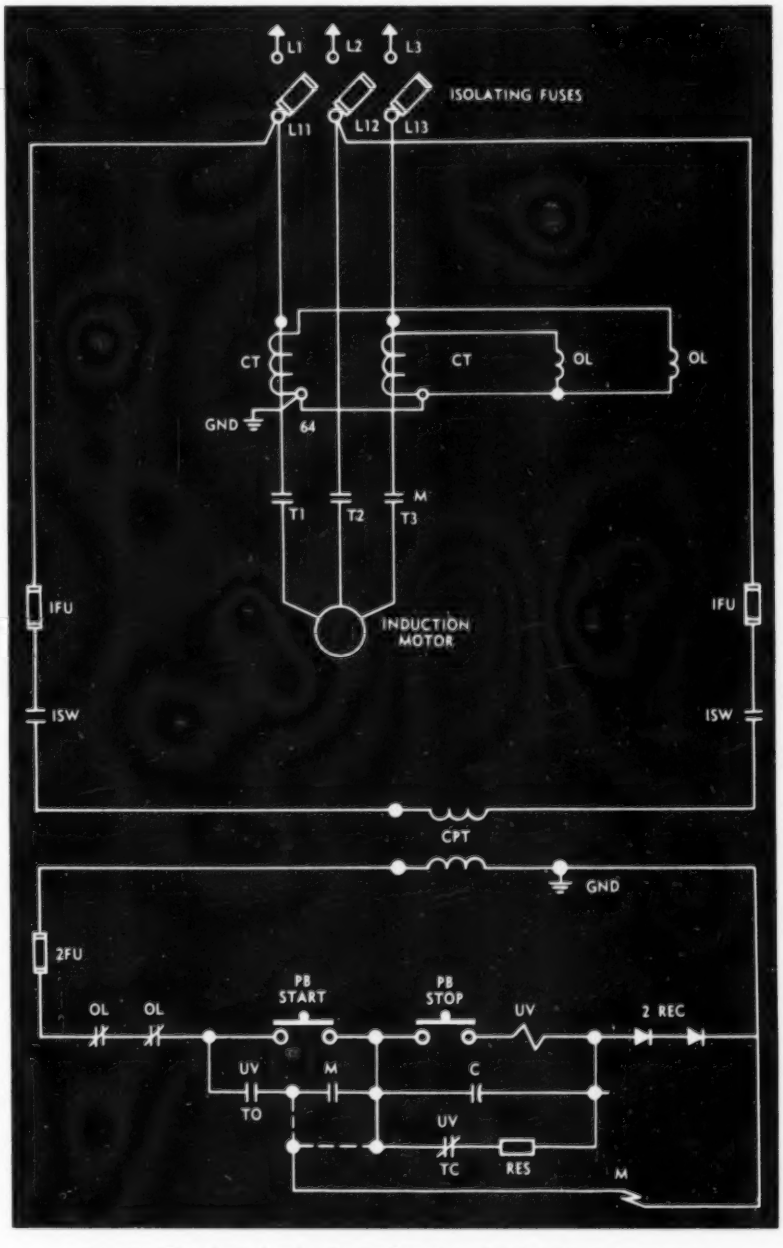



**FIG. 1**—Electrical circuit of a "refinery-type" induction motor starter

## How Is Your Electrical Problems Data File?

In case you've missed them, here's a list of articles pertinent to electrical problems in petroleum processing plants that have been published in recent issues of PETROLEUM PROCESSING. Check through your own copies and clip these articles to build up your data file.

—How to Get What You Need When You Order Electric Motors, by David P. Thornton, Jr., Southwestern Editor, Sept., 1953, pp. 1318-1324.

—Electrical Distribution Systems, Five Factors in their Design for Refineries, by W. A. Sibson, H. G. Buch, and J. F. Eisenhardt, Socony-Vacuum Oil Co., Inc., Paulsboro, N. J., Sept., 1953, pp. 1342-1344.

—Electric Motor Lubrication, One Refiner's Five-Year Test Indicates Bearings with Sealed Lubricants Have Low Maintenance Requirements, May, 1953, p. 693.

—Electrical Installations in Refineries, Rules of Recommended Practices is Current Project of the API Committee on Electrical Equipment, by L. M. Goldsmith, Atlantic Refining Co., Philadelphia, April, 1953, pp. 527-529.

—Electric Power for Refineries, Its Generation and Distribution, by R. F. Lawrence and H. B. Thacker, Westinghouse Electric Corp., Pittsburgh, Pa., March, 1953, pp. 364-367.

the requirement of interrupting safely in a hazardous atmosphere.

The fuses are of the disconnecting type. If they are opened, the arc thus caused will not compromise the explosion-resisting properties of the equipment.

The front view in the photograph of Equipment **E** shows the high-voltage disconnecting switch electrically located in the primary of the control transformer. This device serves as a watchdog to prevent opening of the primary fuses under motor load or even the magnetizing current of the control transformer. Magnetizing current in the control transformer can, of course, produce an arc sufficient to set off an explosion under the right conditions.

**It works this way.** The high-voltage control switch, the primary fuses, and the control circuit fuses are all located in the high-voltage compartment near the top front of the starter. The door to this compartment is mechanically interlocked with the high-voltage oil-immersed door switch. The door cannot be opened until the oil-immersed control switch is manually opened. The opening of this manual door switch takes place under 6 in. of oil. Again, this device meets the requirements of a Class I, Group D, Division 2 atmosphere.

**What does opening this door switch accomplish?** It opens the primary (high-voltage) winding of the control transformer. This removes all power from the control circuit and de-energizes the main line contactor **M.** The control-circuit transformer would still have magnetizing current flowing in its primary even though all load has been removed from the secondary.

This is a clue which explains why the door switch must be a high-voltage device and why it must be in the primary of the control transformer. When the switch is opened, there is no current flowing in the control circuit or the power circuit. As a result, there is no danger of sparking. The door to the high-voltage fuse compartment can now be opened. The high-voltage fuses can be safely opened or removed.

This equipment is available in 2300 or 4160 volts and has an interrupting capacity of 150,000 kva at 2300 and 250,000 kva at 4160 volts. It meets fully the intent of Class I, Group D, Divison 2 Classification. Again, it must be recognized that in high-voltage equipment, a designer can only follow the intent of the Underwriters' requirements. Their standards do not apply to equipment above 600 volts.

## Meet the Authors

Mr. Ellis

Mr. Maynard

Lee T. Ellis and A. R. L. Maynard are sales engineers with General Electric Co. at Philadelphia, concerned primarily with service to the petroleum industry.

Mr. Ellis began his association with GE in 1937 while attending Drexel Institute of Technology, where he was graduated in 1941 with a B.S. in Electrical Engineering. Prior to his present post, he was in switchgear engineering on various assignments.

A Native of Haddonfield, N. J., Mr. Ellis now resides in Philadelphia with his wife, son and daughter. He is a member of the American Petroleum Institute, Engineering Club of Philadelphia, and Society of Naval Architects & Marine Engineering.

Mr. Maynard was graduated from Clemson College in 1943 with a B.E.E. degree, and is now attending Drexel in quest of an M.B.A. With GE since 1946, he had been a control engineering specialist before going to his present post in Philadelphia.

A native of Columbia, S. C., he also resides in Philadelphia with his wife and daughter. Mr. Maynard is a member of American Institute of Electrical Engineers, Tau Beta Pi, and Phi Kappa Phi.

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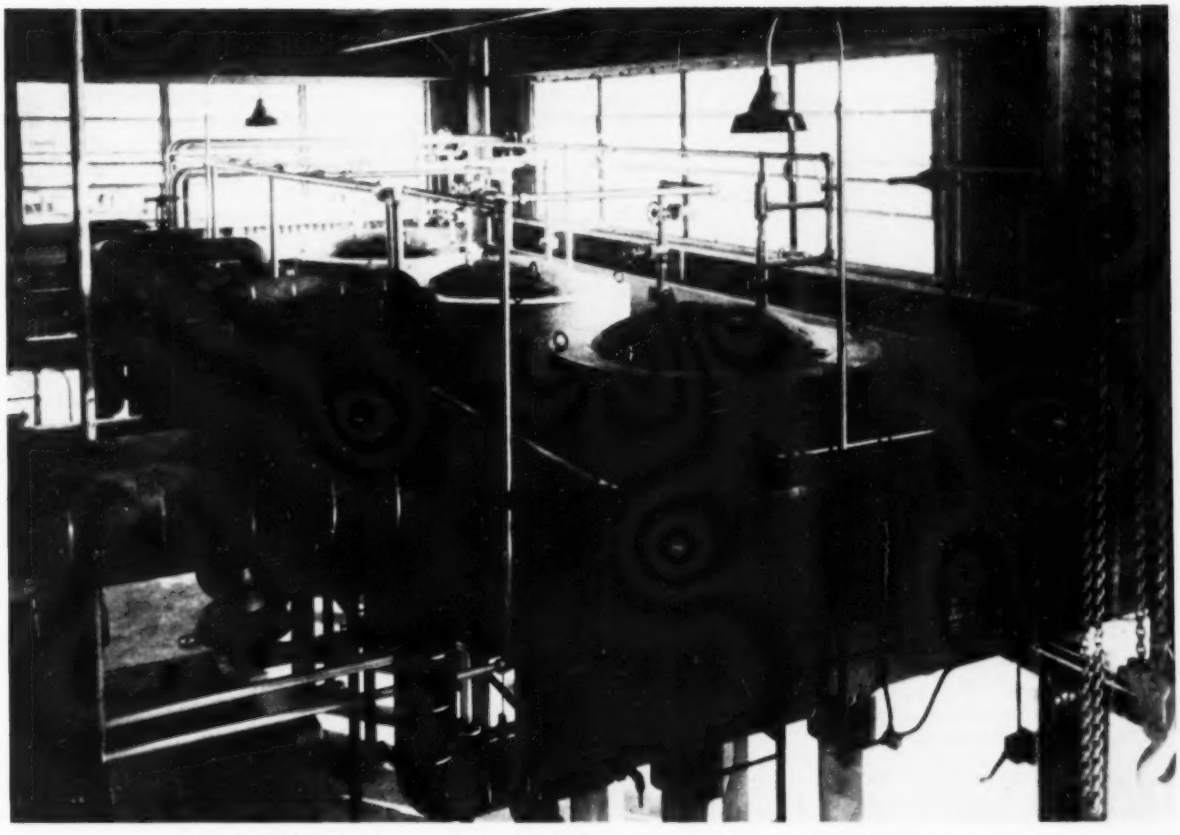
(2) "Control and Switchgear for the Oil Industry," B. M. Mills, 16th Midyear meeting, American Petroleum Institute Division of Refining, Tulsa, Okla., 1951.

(3) "Electric Power in Oil Refining," H. M. Stewart; Petroleum Electric Power Association meeting Nov. 19, 1951, Houston, Texas.

(4) "Activities of the Electrical Equipment Subcommittee, Refining Division of API," L. M. Goldsmith; *Electrical Engineering*, May, 1953.

(5) National Electrical Code, 1951.

(6) NEMA Industrial Control Standards.



**THESE THREE UNITS** in Cit-Con's filter building are run cyclically for continuity of operation

# After-Filters Remove Wax "Haze"

## Here's how Cit-Con solved a problem of haze in lube oils with some extra filters

***By D. P. THORNTON, Jr.***
***Southwestern Editor***

THE problem of removing minute quantities of wax from unblended lubricating oil base stocks following conventional filtration has been solved by the installation of special cartridge-type after-filters at Cit-Con Oil Corp.'s Lake Charles, La., refinery. The idea of after-filters is almost as old as the manufacture of lubricating oils. However, in the past this often has meant an expensive, messy, labor-consuming operation. The arrangement Cit-Con has installed gets the job done without these objections.

There have been several "extra dividends" in consequence, aside from the principal aim of eliminating the wax.

1—The after-filters earn their salt by giving warning that leaks have developed in the main vacuum-type rotary drum filters, usually before they are otherwise detected.

2—In the event a large hole suddenly develops in the cloth of a primary filter, serious contamination of finished product is prevented and time is made available to find and shut down the offender.

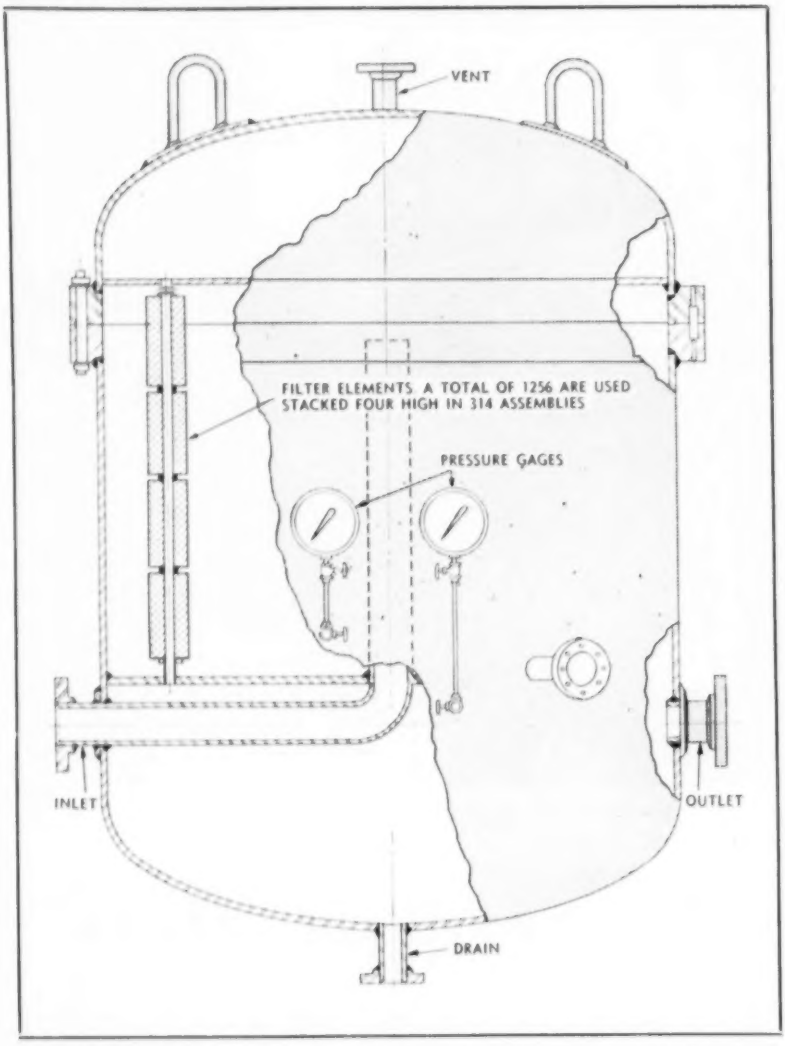
3—Maintenance can be reduced because cloths can be run longer between replacements—at $1200-$1500 per filter turn-around—because the after-filters will catch wax which passes through a leaky cloth.

4—Effective filter capacity of the installation is increased by reason of longer on-stream periods for the primary filters.

5—Operating and maintenance cost of the after-filters is minor.

The presence of these small quantities of wax formerly was visibly evident in the Cit-Con bright stock as a very faint "haze" at room temperatures. However, it was not detected by the standard ASTM cloud and pour tests. Neither did it adversely affect the quality of the bright stock or the finished lubricant blends ultimately made from it.

Indeed, the "haze" is rarely observed in most dark-colored oils, although it may well be present. This is simply a phenomenon of vision which a photographer would ascribe to "relative contrast." The dark-colored oils have a much lower light-transmission than light-colored oils and, combined with the effects of color, the light-scattering or "blurring" effect of the haze is almost or completely masked. Even with light-colored bright stocks, the haze cannot be detected without care-




**INTERNAL ARRANGEMENT** of the cartridge-type after-filter used for dehazing bright stock

ful examination and is most apparent when an identical haze-free oil is available for direct comparison.

Generally, "wax haze" is not present in blended lubricating oils purveyed to the ultimate consumer because of the greater solubility for wax which is characteristic of the light neutral oils usually used in bringing the lubricant to the desired viscosity grade. Disappearance of the haze in blended oils thus is not attributable to the incorporation of additives to impart other qualities.

**Then why worry about it?** Cit-Con's scientists objected to the "haze" principally because "it shouldn't be there," even though tests already had quickly proved it harmless since the oils with it met or exceeded all specification requirements. The haze was noted primarily because the Cit-Con bright stock which is shipped from the plant unblended, characteristically has an unusually light color for "heavy" bright-stock.

The haze could not be attributed to inadequacies in processes, process combinations, or crude. Other refiners, using different processes and crude oils, found the haze also in their unblended stocks—which normally are sold as blended lubricants. Selling unblended base stocks infrequently and in limited amounts, special operating wrinkles apparently were not too onerous a chore.

Extensive investigation by Cit-Con disclosed that the wax causing the haze:

1—Generally was present in quantities not exceeding 0.2%.

2—Was identical to that normally removed during filtration and could be removed by filtration in the laboratory.

3—Was not characterized by unusually small particle size. This led to the conclusion that the wax comprising the objectionable haze was getting by the usual battery of vacuum rotary-drum filters used in conventional solvent dewaxing. Experiments with various cloths and filter-aids did not eliminate the problem.

The obvious by-passing which was letting the wax through theoretically just should not happen, but it was. Long observation showed that tiny holes do develop in all filter cloths. It is believed that they are due to abrasion resulting from the alternate flexing of the cloth against the "winding wire," which holds the cloth against the rotating drum face, and the supporting wire mesh which backs up the cloth. This flexing is inherent in the filter cycle which first sucks and then blows back to loosen the accumulated wax cake once each revolution. Moreover, sizable holes may suddenly develop during operation, as every lube plant operator knows only too well, and leaks also may occur from improper cloth installation.

**In Cit-Con's case,** the same filters are used (blocked operation) to process both a 650 viscosity neutral and a heavy bright stock. The cloth is subjected to as much as a 5 psi. differential pressure during the blow-back portion of the cycle. These factors, it was reasoned, were quite sufficient to account for the observed 0.1% to 0.2% of wax in the refined oil.

After further study and extensive laboratory investigation, Cit-Con's technologists concluded that a second, clean-up filtration might be made to do the job. The question was how to effect additional filtration, as rerunning filtered stock through the existing filters was considered impractical for obvious reasons.

Numerous possibilities in varied designs of commercially available filters were considered and tried and rejected. Finally, a cartridge-type of filter made by Commercial Filters Corp., was found which, after extensive testing, proved adaptable to the Lake Charles requirement.

Until then this filter had never been supplied in the size (700 gpm.) which Cit-Con needed.

As installed at Lake Charles, this equipment consists of 61¼-in. O.D. by 87½-in. high cylindrical vessel containing 1256 individual filtering elements 10-in. long by 2¾-in. O.D. These are in the form of hollow tubes having an inner support 1-in. in diameter of heavy metal mesh on which is

wound a heavy cotton "roving," or yarn.

The manufacturer states that this highly absorbent, specially purified cotton (cellulose) "roving" is precision-wound on the metal mesh core to produce a thick cylindrical wall, traced radially by a diamond-shaped network of passages. During winding, carders draw enough "fuzz" of cotton fibers from the roving to spread it across the diamond-shaped passages, and each successive layer of roving anchors down the free ends, so that there is no migration of fibers in use.

**The fluid being filtered** is forced by pressure from the outer wall of the element inwardly to the core, traversing successively denser layers of fine cotton fibers. This results in the coarser solids being trapped by the fibers on the surface of the element and the fines by the denser, inner layers. This amounts to what may be termed "filtration in depth" and reportedly greatly increases the effective filtering surface over the apparent 78.5 sq. in.

Four of these elements are stacked end-to-end with spacers in between which seat tightly on the elements and thus provide a leak-tight seal between elements. The stack is internally traversed by a triangular center post, to hold the stack upright during installation and prevent buckling between elements. A blank cap is placed on the top end, bearing against a top seat plate and spring assembly which in turn bears on a solid header plate, integrally a part of the flanged cover head attached to the shell.

The other end of the stack of elements bears on a bottom seat plate securely fastened into a hole in the separator plate through which the inner filtrate openings of the elements give into a filtrate sump. The filter contains 314 such stacks in parallel. When the cover head is drawn down, the upper and bottom seat plates and the spacers hold the individual elements so tightly there is no possibility for a leak.

Chilled oil solution from the filtrate receivers of the rotary filters enters the after-filters (which run liquid-full) through gl. a centrally-located inlet pipe. The solution flows inward through the elements and down their open cores into a filtrate sump and outlet located below the separator plate in the bottom of the vessel.

Three of these vessels are installed in parallel at Lake Charles. As a group, they are in series between the rotary drum filters and the heat exchangers used as precoolers for waxy oil charge to the unit. The then-warmed, dewaxed oil solution flows to a surge tank serving the solvent recovery facilities.

**About the greatest complication** in installing the filters was the necessity of adding a 20-ft. bay to one end of the existing filter building. Processwise, the installation was very simple. The main line leading to the product-to-charge exchangers was opened and two tees with a block valve between were installed.

The stem of the up-stream tee was connected to an inlet manifold serving the filters and the stem of the down-stream tee to another manifold serving as the outlet. These manifolds are so valved as to permit any one or pair of filters to be operated in parallel, or by-passing the after-filter bank as desired. Also connected to the manifolds are lines to and from the MEK solvent surge tank; the incoming wash solvent may be warmed or cooled with steam or plant cooling water when desired by means of a special exchanger set for that purpose.

Originally, it was believed that the volume of wax by-passing the main filters would be sufficient to require two of the cartridge-type after-filters operating in parallel to handle the stream. The idle unit was to serve as a spare during washing of one of the other two filters. In practice, this has proved unnecessary and only one cartridge filter is on the line at any one time. This is an unexpected advantage, as ample time is thus available for washing.

No attempt is made to segregate the wax caught on the after-filters. The wax is soluble in the warm wash solvent, which enters in the same flow direction as the filter oil-solvent solution, and remains in the solvent supply. No wax is lost, however, in that it is eventually caught on the large drum filters. The quantity of wax thus introduced into the fresh solvent is not enough to be noticed when the solvent is mixed with waxy oil at the beginning of the dewaxing step.

Likewise, there is no attempt to recover oil remaining in the vessel when the cartridge filter is taken off the line for hot-washing. This oil, too, returns with the warm solvent to the solvent surge tank.

**At the conclusion of hot-washing,** the warm solvent is diverted to a small heat exchanger before entering the filter. This arrangement permits cooling the warm solvent as low as the plant cooling water supply will take it. No attempt is made to pre-chill the next filter to go on the line to the usual 0° F haze removal temperature.

The only precaution the operators take in switching filters is to make the change-over from filtration to washing very slowly whenever it is necessary to hot-wash immediately. Normally an hour or more may be allowed for natural warm-up before washing.

Originally instrumented for time-cycle control, manual control is now the operation of choice. Decision is made to switch filters on the basis of pressure differential existing across the filter. Usually when the differential reaches somewhere around 30 psi. the operator makes a switch. Initial pressure-drop across a clean filter does not exceed 1 psi.

**The on stream time** for a filter varies widely. With the 650 vis. neutral this may be almost indefinite, so slowly does the leakage wax accumulate. On the other hand, with the heavy bright stock the cycle generally ranges between six and eight hours, or as low as three hours, depending on the condition of the cloth on the primary filters.

This is a valuable indication of the performance of the drum filters, and makes it unnecessary for the operator to carefully inspect each one, looking for holes. So long as the time-cycle on the after-filters remains normal for the stock, there are no holes of consequence in the big filters and inspection may be rather cursory.

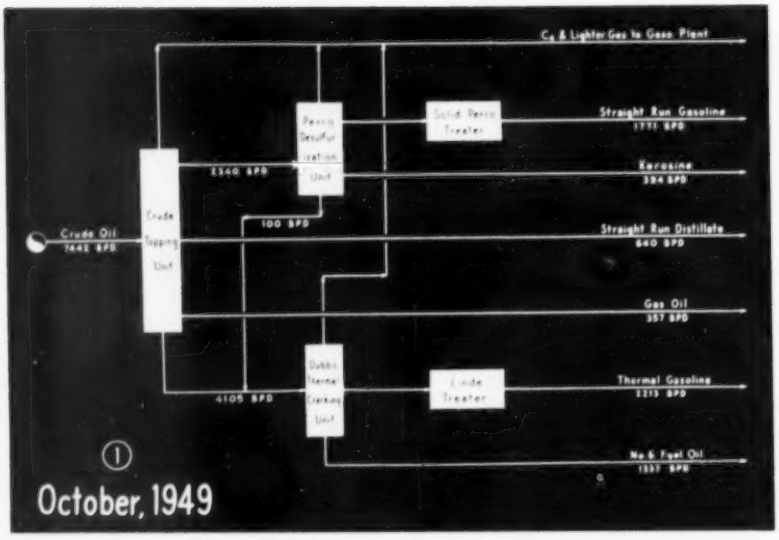
Only when the time-cycle shortens materially does the operator start inspecting the main rotary filters in earnest. Usually the hole can be found by simply watching the filter drum—meanwhile with the assurance the filtered oil is not being contaminated by wax, thanks to the after-filters.

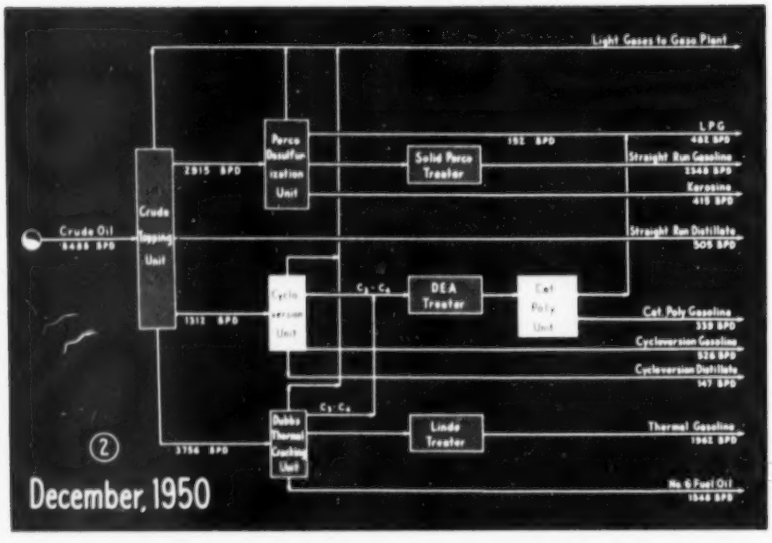
**Little maintenance attention** is required by the cartridge-type after-filters. Simple washing to remove wax and no moving parts, plus the almost complete absence of erosion, leaves little that could happen. It is possible, but unlikely, that solids which could not be removed by washing ever would get by the main rotary filters except by mischance. Cit-Con now has adequate data to estimate practical cartridge-life.

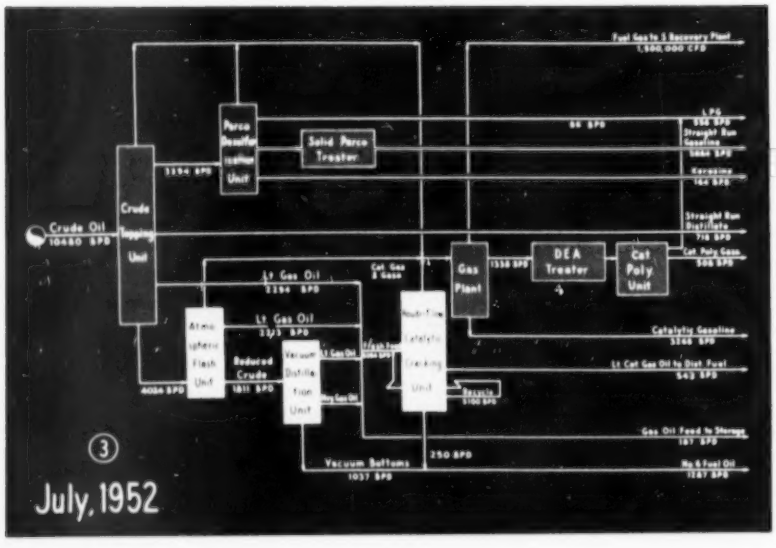
**In event of a failure** allowing wax to get through, it usually is first signaled by a failure of pressure differential to develop after a short length of time on-stream, as dictated by experience, and concurrently by the rapid increase in pressure build-up by a "detector" device installed downstream from the after-fillers.

**Illustrations**

Photographs accompanying this article were furnished through the courtesy of The Lummus Co. and Shaw Engineering Co.




# If You Can't

**By DAVID B. ARDERN**
***Houdry Process Corp.***
***Marcus Hook, Pa.***

AN intensified and well-planned modernization program can quickly improve the competitive position of even a small refiner in today's markets. That point has been strikingly illustrated at the McKee refinery of Shamrock Oil and Gas Corp. in Sunray, Texas.

Beginning in 1950, Shamrock initiated a modernization program at its McKee plant which in the four ensuing years has resulted in the following improvements in the company's position:

**Crude runs have increased** 38%, from 7,440 b/d in 1949 to 10,300 b/d last year.

**Gasoline yield has been raised** from 53.6 vol.-% on crude to 66.5 vol.-%.

**Product quality has improved** from a composite refinery gasoline blend of 80 octane (research, with 3 cc. TEL) in 1949 to 90 octane today.

Significant also in the marketing area served by this refinery is a reduction in heavy fuels production from 18% originally to 12.5%, while total liquid recoveries now average 98.3%

**Table 1— Typical Overall Refinery Yields 1949-1952**

| | Oct. 1949 | | Dec. 1950 | | May-July 1952 | |
|---|---|---|---|---|---|---|
| | BPSD | Vol.-% | BPSD | Vol.-% | BPSD | Vol.-% |
| Crude Oil Charged | 7442 | 100.0 | 8488 | 100.0 | 10293* | 100.0 |
| **Products:** | | | | | | |
| Straight Run Gasoline | 1771 | 23.8 | 2348 | 27.7 | 3064 | 29.8 |
| Thermal Gasoline | 2213 | 29.8 | 1962 | 23.2 | | |
| Cycloversion Gasoline | | | 526 | 6.2 | | |
| Cat. Poly. Gasoline | | | 339 | 4.0 | 508 | 4.9 |
| Catalytic Gasoline | | | | | 3268 | 31.8 |
| Total Gasoline | 3984 | 53.6 | 5175 | 61.1 | 6840 | 66.5 |
| Straight Run Kerosene | 394 | 5.3 | 415 | 4.9 | 164 | 1.6 |
| Straight Run Distillate | 640 | 8.6 | 505 | 6.0 | 718 | 7.0 |
| Straight Run Gas Oil | 357 | 4.8 | | | | |
| Cycloversion Distillate | | | 147 | 1.7 | | |
| Lt. Catalytic Gas Oil | | | | | 543 | 5.3 |
| Total Distillate Fuel Oils | 1391 | 18.7 | 1067 | 12.6 | 1425 | 13.9 |
| Heavy Catalytic Gas Oil | | | | | 250 | 2.4 |
| Vacuum Tower Btms. | | | | | 1037 | 10.1 |
| Thermally Cracked Residuum | 1337 | 18.0 | 1548 | 18.2 | | |
| Total Heavy Fuel Oils | 1337 | 18.0 | 1548 | 18.2 | 1287 | 12.5 |
| L. P. Gas | | | 482 | 5.7 | 556 | 5.4 |
| TOTAL LIQUID RECOVERY | 6712 | 90.3 | 8272 | 97.6 | 10108 | 98.3 |

* Gross crude charged 10480 BPSD, less 187 BPSD excess catalytic charge stock returned to storage gives net quantity of crude fully processed of 10293 BPSD.

# Modernize All at Once—Do It in Steps

## That's what Shamrock Oil and Gas did in a 4-year program for its McKee refinery

on crude vs. 90.3% before modernization.

**Major unit installed** during this period was a 11,000 b/d (total feed) Houdriflow catalytic cracking unit which, although designed for normal conversion of 78 vol.-% of virgin gas oil feed (5,900 b/d), has consistently operated at 85% conversion and at times above 90%. This unit satisfactorily handles a wide-cut gas oil, including a vacuum distillate with a boiling range above 1100° F. Operators have achieved production of catalytic plus cat-poly gasoline amounting to nearly 80% of virgin reactor charge.

Shamrock's refining facilities, consisting of the refinery and associated natural gasoline plant at Sunray, in Moore County, Texas, process crude and natural gas from Moore, Sherman and Hutchinson counties. Gasoline plant production is not considered in refinery throughput in this article.

**Prior to 1950,** the McKee refinery at Sunray consisted essentially of a crude distillation unit, Dubbs thermal cracking, and desulfurization and treating equipment. A block flow diagram of the plant at that time is shown in Fig. 1. Overall refinery yields for October, 1949, are representative of refinery operation just prior to modernization, as shown in Table 1.

At this time, crude throughput was approximately 7,440 bbls. per stream day. Gasoline production averaged 3,980 b/d, representing 53.6 vol.-% of crude, of which a little less than half was straight-run and the balance thermal cracked. Octane number of the composite refinery gasoline blend averaged about 65.5 (research) and 80 oct. with 3 cc TEL. Thermally cracked residuum constituted 18 vol.-% of crude charge.

**In the Spring of 1950** Shamrock installed a Cycloversion unit and catalytic polymerization. Fig. 2 shows the incorporation of these units into the refinery processing scheme and typical refinery yields also are shown in Table 1.

The addition of these two units effected considerable improvement in product distribution. Plant throughput also was increased, so that the December, 1950, yield figures show the plant processing about 8,500 bpsd. Total gasoline yield had improved to 61.1 vol.-% of crude from the former 53.6%, while the quality of composite refinery gasoline was about 69.5 oct. (research) clear and 83 research with 3 cc TEL. Recovery facilities for LPG then were available and total liquid products recovery reached 97.6% on crude.

However, this increase in gasoline yield was accomplished at the sole expense of distillate fuel oil since there was no decrease in the yield of heavy fuel. Distillate fuel yield dropped from 18.7 to 12.6 vol.-% of crude. The production of distillate fuel actually decreased from 1,391 b/d to 1,067 b/d in spite of the increase in crude processed. On the other hand, the volume of thermally cracked residuum remained at 18 vol.-% of crude, and the problem of disposing of 1,550 b/d of heavy fuel appeared to be the limiting factor in balanced refinery operation.

**In 1951** Shamrock erected a Houdriflow catalytic cracking unit. Concurrent additions included a vacuum tower to prepare additional catalytic unit charge stock and a complete new

### Table 2—Houdriflow Unit Material Balances, 90% Conversion

| | 12/12-14/51 | | | | 1/13-15/52 | | | |
|---|---|---|---|---|---|---|---|---|
| **Charge:** | **BPSD** | **Vol.-%** | **lb./hr.** | **Wt.-%** | **BPSD** | **Vol.-%** | **lb./hr.** | **Wt.-%** |
| Fresh Gas Oil | 4204 | 100 | 52897 | 100 | 4749 | 100 | 59166 | 100 |
| Recycle Gas Oil | 5660 | 134 | 72783 | | 5736 | 121 | 74195 | |
| Total | 9864 | | | | 10485 | | | |
| **Products:** | | | | | | | | |
| Gasoline, $C_5$+/430° EP | 2840 | 67.5 | 30672 | 58.0 | 3138 | 65.1 | 33942 | 57.4 |
| Light Catalytic Gas Oil | 275 | 6.5 | 3546 | 6.7 | 335 | 7.1 | 4324 | 7.3 |
| Heavy Catalytic Gas Oil | 61 | 1.5 | 804 | 1.5 | 104 | 2.2 | 1372 | 2.3 |
| Butanes | 417 | 9.9 | 3452 | 6.5 | 489 | 10.3 | 4041 | 6.8 |
| Butylenes | 400 | 9.5 | 3530 | 6.7 | 459 | 9.7 | 4056 | 6.9 |
| Propane | 196 | 4.7 | 1453 | 2.7 | 218 | 4.6 | 1616 | 2.7 |
| Propylene | 358 | 8.5 | 2630 | 5.0 | 399 | 8.4 | 2930 | 5.0 |
| Total $C_3$+Liquid | 4547 | 108.1 | 46087 | 87.1 | 5142 | 107.4 | 52281 | 88.4 |
| Ethane | | | 792 | 1.5 | | | 821 | 1.4 |
| Ethylene | | | 427 | 0.8 | | | 441 | 0.7 |
| Methane | | | 928 | 1.8 | | | 958 | 1.6 |
| Hydrogen | | | 63 | 0.1 | | | 65 | 0.1 |
| Total Dry Gas | | | 2210 | 4.2 | | | 2285 | 3.8 |
| Coke | | | 4600 | 8.7 | | | 4600 | 7.8 |
| Total | | | 52897 | 100.0 | | | 59166 | 100.0 |
| Conversion | | 92.0 | | | | 90.7 | | |
| Cracking Efficiency | | 73.5 | | | | 72.8 | | |

### Table 3—Inspection of Stream Samples —Houdriflow Unit—Charge & Products

| **Stream** | **Gr.** | **ASTM DISTILLATION—F.** | | | | | **Flash** | **$F_1$ Octane** | |
|---|---|---|---|---|---|---|---|---|---|
| Period: 12/12-14/51 | **°API** | **IBP** | **10%** | **50%** | **90%** | **EP** | **RVP** | **Pt.** | **Cl.** | **3cc.** |
| Fresh Feed | 32.2 | 448 | 552 | 669 | 62% @ 700 | | | | | |
| Total Feed—including recycle | 30.3 | 467 | 538 | 634 | 73% @ 700 | | | | | |
| Catalytic Gasoline—stab. btms. | 59.1 | 115 | 139 | 228 | 380 | 428 | 6.0 | | 88.0 | 95.9 |
| Naphtha* | 34.3 | 337 | 391 | 410 | 435 | 455 | | | | |
| Light Cat. Gas Oil | 28.3 | 418 | 462 | 479 | 506 | 542 | | 148 | | |
| Heavy Gas Oil—tower btms. | 25.3 | 515 | 585 | | | | | | | |
| Period: 1/13-15/52 | | | | | | | | | | |
| Fresh Feed | 34.0 | 379 | 495 | 680 | 56% @ 700 | | | | | |
| Total Feed—including recycle | 30.6 | 474 | 526 | | 69% @ 700 | | | | | |
| Catalytic Gasoline—stab. btms. | 58.8 | 114 | 138 | 232 | 389 | 430 | 6.2 | | 88.1 | 96.0 |
| Naphtha* | 34.4 | 345 | 388 | 408 | 432 | 456 | | | | |
| Light Cat. Gas Oil | 28.2 | 425 | 459 | 473 | 502 | 546 | | 138 | | |
| Heavy Gas Oil—tower btms. | 24.8 | 556 | 616 | | | | | | | |

* Naphtha cut from synthetic crude tower is used as absorber lean oil, then goes to stabilizer.

### Table 4—Analyses of Light Hydrocarbons—Houdriflow Unit

**Date: 12/10/51**

| | **Deethanizer Overhead: Fuel Gas to Boiler House —Mol.%** | **Debutanizer Overhead Feed to Cat. Poly. Unit —Liq. Vol.%** |
|---|---|---|
| Methane | 54.5 | |
| Ethylene | 9.3 | |
| Ethane | 15.5 | 0.4 |
| Propylene | 13.1 | 19.0 |
| Propane | 6.1 | 11.4 |
| Butanes | 1.6 | 33.5 |
| i-Butylene | | 21.2 |
| n-Butylenes | | 12.1 |
| i-Pentane | | 2.4 |
| TOTAL | 100.0 | 100.0 |

gas plant. The Dubbs and Cycloversion units were shut down when the Houdriflow unit went on stream, as shown in Fig. 3.

The average refinery yields for May-June, 1952, shown in Table 1, are typical of the degree to which refinery operation was improved by addition of the Houdriflow unit and other facilities. Refinery crude throughput was increased to 10,300 bpsd. Thus, in a period of only two and one-half years the overall expansion program effected a 38% increase in crude runs.

As indicated in Figure 3, approximately one-half of the total reactor feed was composed of fresh feed, which in turn consisted of about 43% crude tower gas oil, 42% flash tower virgin gas oil and 15% vacuum tower virgin gas oil. The other half of the total feed was recycle gas oil.

Total motor gasoline production amounted to 6,840 b/d, or 66.5% of the crude charge. This is a 70% increase over the gasoline produced in October, 1949, and 30% more gasoline than was available in December, 1950. Further, the octane rating of the composite refinery gasoline blend was increased to about 78 oct. (research) clear and 90 oct. with 3 cc. TEL.

The addition of catalytic cracking has had a significant effect upon fuel oil production. While thermal operation improved gasoline yield only at the expense of the distillate fuels and left a disconcertingly large proportion of heavy fuel, the Houdriflow unit, with its facilities for handling liquid feed charge stocks, increased the gasoline with concurrent reduction of heavy fuel. The total production of heavy fuel was reduced from 18 to 12.5% on crude and thermally cracked residuum was completely eliminated.

**A high conversion level** at normal operations—78 vol.-% on 5,900 b/d of virgin gas oil—was designed into the Shamrock Houdriflow unit, but the unit has consistently operated at 85% conversion, and at times conversions in excess of 90% have actually been realized.

Table 2 shows the units material balances for two periods in December, 1951, and January, 1952, which are typical of the operations at better than 90% conversions. These balances have been computed from refinery data. Routine inspection data of charge and product streams for these periods are given in Table 3, and Typical light hydrocarbon stream analyses in Table 4.

A blend of light virgin and vacuum gas oils from Hutchinson-Moore crude, representing approximately the 40 to 90% cut, constituted the virgin feed at the time. The catalytic unit total charge included internal recycle at about 1.25/1.0 ratio on fresh feed. The catalytic gasoline produced as stabilizer bottoms had a 430° F. ASTM end point, 6-lb. RVP and rated 88 oct. clear and 96 leaded (3 cc. TEL). In the Houdriflow material balances this gasoline is 65 to 67.5 vol.-% of reactor virgin charge.

The debutanizer overhead, containing the bulk of the $C_3$-$C_4$ production from the Houdriflow unit, went to the cat. poly unit. The total yield of 10-lb. RVP catalytic plus cat. poly.

gasoline for the two weight balance periods is 78-80 vol.-% of the fresh feed to the Houdriflow reactor.

This type of operation is important at Shamrock, where the market for fuel oil is limited and maximum gasoline yield is desired. Only 60 to 100 b/d of heavy catalytic gas oil were taken as a bottoms stream from the synthetic crude fractionation tower. That stream was used to cut vacuum tower bottoms to No. 6 fuel oil. About 300 b/d of light catalytic gas oil having a 420-540° boiling range were obtained.

**A propane deasphalting unit** was placed in operation at the McKee refinery early in 1953, and has helped Shamrock handle its heavy fuel oil problem. This new unit produces about 850 b/d of propane deasphalted heavy gas oil from vacuum tower bottoms. The gas oil is approximately the 90-96% cut, leaving only about 4% asphalt bottoms, based on crude. The gas oil from deasphalting is extremely heavy; a laboratory vacuum distillation shows the 5% overhead temperature is 1050° F. at atmospheric pressure.

Shamrock has been blending 800-900 b/d of deasphalted gas oil into the normal Houdriflow charge since Feb. 9, 1953. The additional very heavy feed has been cracked to a good product distribution with no operating difficulties.

The following is a typical vacuum distillation of the total reactor charge stream:

| | | |
|---|---|---|
| Vacuum assay, | 10% | 577° F. |
| | 30 | 643 |
| | 50 | 683 |
| | 70 | 773 |
| | 90 | 935 |
| | 95 | 1,004 |
| | 98 | 1,060 |

This material is about 5% vaporized under normal conditions of 730° F. and 45 psig at the outlet of the Houdriflow reactor preheat furnace.

For a seven week period, from March 15 through May 3, 1953, the following average values, based on fresh feed, were obtained from refinery yield data:

| | b/d | vol.-% |
|---|---|---|
| Fresh feed to reactor | 6,290 | |
| Total feed to reactor | 11,090 | |
| Recycle ratio | 0.76:1 | |
| Debutanized gasoline | 3,620 | 57.5 |
| Light catalytic gas oil | 1,080 | 17.2 |
| Heavy catalytic gas oil | 450 | 7.1 |
| $C_3 - C_4$ cut | 1,680 | 26.7 |
| $C_3$ + liquid recovery | 6,830 | 108.5 |
| Conversion | | 75.7 |
| Cracking efficiency | | 75.9 |

Table 5 is a complete unit material balance for April 29, 1953, when the fresh feed contained about 850 bbls. of propane deasphalted gas oil.

## Table 5—Houdriflow Unit Material Balance 850 Barrels Propane Deasphalted Gas Oil in Fresh Feed

Date: 4/29/53

| Charge: | BPSD | Vol.% | °API | lb./hr. | Wt.% |
|---|---|---|---|---|---|
| Fresh Feed | 5876 | 100.0 | 31.0 | 74,600 | 100.0 |
| Recycle | 5503 | 93.9 | | | |
| Total | 11,379 | | | | |
| **Products:** | | | | | |
| Gasoline, $C_5$+/430° EP | 3395 | 57.8 | 60.3 | 36,500 | 48.9 |
| Light Catalytic Gas Oil | 993 | 16.9 | 32.4 | 12,510 | 16.8 |
| Heavy Catalytic Gas Oil | 332 | 5.6 | 26.8 | 4,320 | 5.8 |
| Butanes | 455 | 7.7 | | 3,763 | 5.0 |
| Butylenes | 460 | 7.8 | | 4,050 | 5.4 |
| Propane | 365 | 6.2 | | 2,711 | 3.6 |
| Propylene | 446 | 7.6 | | 3,278 | 4.4 |
| Total $C_3$+Liquid | 6446 | 109.6 | | 67,132 | 89.9 |
| Ethane | | | | 1,049 | 1.4 |
| Ethylene | | | | 587 | 0.8 |
| Methane | | | | 1,451 | 2.0 |
| Hydrogen | | | | 81 | 0.1 |
| Total Dry Gas | | | | 3,168 | 4.3 |
| Coke | | | | 4,300 | 5.8 |
| Total | | | | 74,600 | 100.0 |
| Conversion | | 77.5 | | | |
| Cracking Efficiency | | 74.6 | | | |

**Shamrock's Houdriflow unit** is of the most recent design, with the reactor superimposed on the kiln in an integrated unit. Briefly, Filtrol pelleted clay catalyst enters the reactor from the top seal leg and flows through reactor and kiln by gravity. Mixed vapor and liquid oil charge enter the reactor through a single nozzle situated above the solid bed reaction zone, mixing with the catalyst in the conventional manner. The design coke burning capacity of the kiln is 6,000 lbs. per hour.

The lift medium used to return regenerated catalyst to the top of the reactor is a mixture of steam and flue gas supplied by thermocompressors. Flow is through three 15-in. (I.D.) lift pipes in parallel, running from the lift engaging hopper below the kiln to the disengaging hopper atop the unit. The thermocompressors, one for each lift pipe, use 150 psig. steam as motive fluid and flue gas from the bottom of the kiln at about 2.5 psig. as suction fluid. The flue gas-steam thermocompressor effluent flows to the lifts at engager pressure, normally 5.5 to 6.5 psig.

Average operating temperatures, pressures and flow data for reactor, kiln and lift system are shown in Table 6.

**Performance** of the Shamrock Houdriflow unit has been very satis-

## Meet the Author

David Ardern received BS and MS degrees in chemical engineering at the U. of Louisville, and then was employed by Tennessee Valley Authority to do research and development work in conjunction with phosphate and nitrate operations at Wilson Dam.

In 1942 he joined Houdry Process Corp. He has been engaged primarily in process design—concentrating on the commercial design of Houdriflow catalytic cracking units, and more recently on Houdriforming units for the catalytic reforming of petroleum naphthas. Since 1942 Mr. Ardern has been Supervisor of Technical Service.

factory. In two years of operation the unit has run with a minimum of supervision and repair, and has demonstrated its ability to take interruptions in stride. In March, 1952, after the first year of operation, the unit was shut down for a general turnaround and inspection. The unit was off-stream 15 days, which included unloading and reloading the catalyst. The turnaround, including feed preparation, distillation and gas plant facilities, was handled by Shamrock's maintenance and operating personnel.

Examination of the reactor showed it to be in excellent condition, requiring merely the removal of a very small coke deposit on the internal surfaces. The kiln also was in good repair. Only minor lining repairs were needed, including replacement of 21 bricks representing less than 0.5% of the total. Louvres on some of the air inlet channels required straightening. The lift system was sound and free of erosion save for minor erosion of the easily replaceable bottom foot of the lift pipes. Some prior trouble with expansion of the lift pipes into the disengager was rectified by installation of a new expansion joint design.

After exactly eleven months of steady operation the unit was shut down March 1, 1953 for its second turnaround. Again inspection showed the unit to be in excellent condition. Some erosion in the reactor vapor disengager was found, which probably occurred during operations considerably above design level. This situation had been anticipated so that a modification in design was ready. The change made will provide ample capacity for considerable increase in reactor vapor loading. Some catalyst erosion of the reactor shell was found at one level. No serious damage had been done but suitable repair was made so that no harm would ensue and future erosion will be prevented.

The kiln was in excellent condition. Only very minor pointing of the brick lining and replacement of a portion of insulation behind the lining was necessary. All cooling coils were found in perfect order, as also were all other kiln internals. The lift system again showed erosion only in the bottom 18 inches. These short lengths were replaced and no other lift maintenance was necessary.

The Houdriflow unit and the feed preparation, distillation and gas plant equipment were off-stream 12 days for this turnaround and again all work was handled with the normal refinery crew.

For the eleven month period between these turnarounds the unit on-stream efficiency was 97.3%. The lost time was due to five interruptions caused by power failures, furnace tube failures and mechanical difficulties. The average conversion for the full length of the run was about 83%.

**Additional facilities**—An alkylation unit has recently been put into operation. This unit is to produce alkylate for aviation gasoline from $C_3$ and $C_4$ olefins and isobutane from the catalytic unit, supplemented with isobutane from natural gasoline.

Shamrock also has installed a sulfur recovery plant which recovers elemental sulfur from hydrogen sulfide extracted from the natural gasoline plant and the refinery fuel gas. This plant currently is producing 30 tons of sulfur daily.

### Table 6—Houdriflow Unit Average Operating Data, Natural Clay Catalyst

| | December 12-15, 1951 | January 13-15, 1952 |
|---|---|---|
| **Oil Charge Rate:** | | |
| Fresh Feed, BPD | 4204 | 4749 |
| Recycle, BPD | 5660 | 5736 |
| Total | 9864 | 10485 |
| **Furnace:** | | |
| Oil Outlet Temp. °F. | 736 | 728 |
| Oil Outlet Pressure PSIG | 45 | 45 |
| **Reactor:** | | |
| Catalyst Circulation, Tons/hr. | 325 | 350 |
| Space Velocity V/hr./V | 1.90 | 2.03 |
| Catalyst/Oil Ratio V/V | 5.5 | 5.7 |
| Temperatures: | | |
| Catalyst to Reactor, °F. | 1090 | 1090 |
| Oil to Reactor nozzle, °F. | 690 | 685 |
| Oil from Reactor, °F. | 880 | 890 |
| Pressures: | | |
| Top of Reactor, PSIG | 6.5 | 6.9 |
| Oil Vapor Outlet, PSIG | 4.5 | 4.8 |
| Steam Flows: | | |
| Purge Steam, #/hr. | 4800 | 5600 |
| Top Seal Steam, #/hr. | 1850 | 1890 |
| Nozzle and Process Steam, #/hr. | 1200 | 1200 |
| Catalyst Hydration, #/hr. | 1590 | 1440 |
| **Kiln:** | | |
| Air Flow, cfm., 90°, 12.9 psia | 25000 | 25000 |
| Temperatures: | | |
| Inlet Air, °F. | 940 | 985 |
| Top Flue Gas Outlets, °F. | 880 | 890 |
| Bottom Flue Gas Outlet, °F. | 850 | 940 |
| Catalyst | | |
| Upper Burning Zone, °F. | 1100 | 1110 |
| Above Cooling Coils, °F. | 1070 | 1100 |
| Below Cooling Coils, °F. | 935 | 960 |
| Kiln Outlet, °F. | 1100 | 1100 |
| **Pressures:** | | |
| Air Blower Discharge, PSIG | 4.65 | 4.65 |
| Air to Bottom Kiln Zone, PSIG | 4.0 | 3.9 |
| Air to Top Kiln Zone, PSIG | 2.3 | 2.6 |
| Flue Gas from Bottom Kiln Zone, PSIG | 2.7 | 3.2 |
| **Steam Production:** | | |
| Cooling Coils in Service | 6 | 5 |
| Steam Pressure, PSIG | 150 | 152 |
| Steam Flow, #/hr. | 43945 | 41690 |
| Including steam produced from syn tower quench and circ. reflux reboilers | | |
| **Catalyst Lift:** | | |
| Temperatures: | | |
| Primary Flue Gas-Steam Supply, °F. | 845 | 860 |
| Flue Gas from Lift Cyclone, °F. | 830 | 800 |
| Catalyst from Lift Disengager, °F. | 1045 | 1045 |
| Pressures: | | |
| Lift Engager, PSIG | 6.05 | 6.35 |
| Lift Disengager, "$H_2O$ | 2.5 | 2.4 |
| Flows: | | |
| Flue Gas-Steam Mixture from Thermocompressors #/hr. | 25,160 | 25350 |

TO HELP YOU DESIGN FRACTIONATORS

# Distillation of Quaternary Mixtures

## Specification of Intermediate Components

## No. 9 in a Series

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THE PRECEDING article of this series discussed quaternary separations in which the concentration of the least volatile component was specified in the distillate and and bottom products. This resulted in the disappearance of more volatile components from the distillate product at minimum reflux over a range of bottom product specifications. This article, the last of the present series, applies the principles developed in the preceding articles to other methods of specifying quaternary separations which also result in the disappearance of components from the products at minimum reflux. The discussion is relatively brief because of its similarity to that of the preceding article.

### Specification of $x_{aD}$ and $x_{dB}$

Consider the example. A saturated liquid feed containing 25.0 mol % each of components *a*, *b*, *c* and *d* having relative volatilities of 3.375, 2.25, 1.50 and 1.00 respectively, is to be fractionated to produce a distillate product containing 50.0 mol % of component *a* and bottom products containing various mol % of component *d*. Determine the range of product variation and the stage requirements as a function of reflux ratio and bottom product specification.

**Solution:** Material balances limit the range of possible products to the areas *LMNO* and *L'M'N'O'* in the planes representing $x_{aD} = 0.50$ and $x_{dB} = 0.408$ respectively in Fig. 1. The coordinates of the various points are listed below.

| Comp. | *L* | *M* | *N* | *O* | *L'* | *M'* | *N'* | *O'* |
|---|---|---|---|---|---|---|---|---|
| *a* | 0.500 | 0.500 | 0.500 | 0.500 | 0.092 | 0.000 | 0.000 | 0.092 |
| *b* | 0.000 | 0.000 | 0.408 | 0.500 | 0.408 | 0.500 | 0.092 | 0.092 |
| *c* | 0.500 | 0.408 | 0.000 | 0.000 | 0.092 | 0.092 | 0.500 | 0.408 |
| *d* | 0.000 | 0.092 | 0.092 | 0.000 | 0.408 | 0.408 | 0.408 | 0.408 |

Similarly, somewhat smaller areas appear in Fig. 2 where $x_{dB} = 0.422$.

### Total Reflux Calculations

The procedure for calculating the number of stages required at total reflux to make products meeting the specifications $x_{aD}$ and $x_{dB}$ may be summarized as follows:

1. Assume $x_{dB}$
2. Calculate $x_{dD}$ from the material balance Equation 2

$$\frac{x_{dD} - x_{dB}}{x_{dF} - x_{dB}} = \frac{x_{aD} - x_{aB}}{x_{aF} - x_{aB}} \qquad (1)$$

or rearranging

$$x_{dD} = x_{dB} + (x_{dF} - x_{dB})\left[\frac{x_{aD} - x_{aB}}{x_{aF} - x_{aB}}\right] \qquad (2)$$

3. Calculate the number of stages, *N*, from Equation 12 of Art. No. 7.[1]

$$N = \frac{\log\left(\frac{x_{aD}}{x_{aB}}\right)\left(\frac{x_{dB}}{x_{dD}}\right)}{\log \alpha_a/\alpha_d} \qquad (3)$$

4. Calculate the values of *B* and *C* from Equation 15 of Art. No. 7.[1]

$$B = \frac{A(\alpha_b^N - \alpha_d^N) + D(\alpha_a^N - \alpha_b^N)}{\alpha_a^N - \alpha_d^N} \qquad (4)$$

$$C = \frac{A(\alpha_c^N - \alpha_d^N) + D(\alpha_a^N - \alpha_c^N)}{\alpha_a^N - \alpha_d^N} \qquad (5)$$

where

$$A = \frac{x_{aF}}{x_{aB}}, B = \frac{x_{bF}}{x_{bB}}, C = \frac{x_{cF}}{x_{cB}}, D = \frac{x_{dF}}{x_{dB}}$$

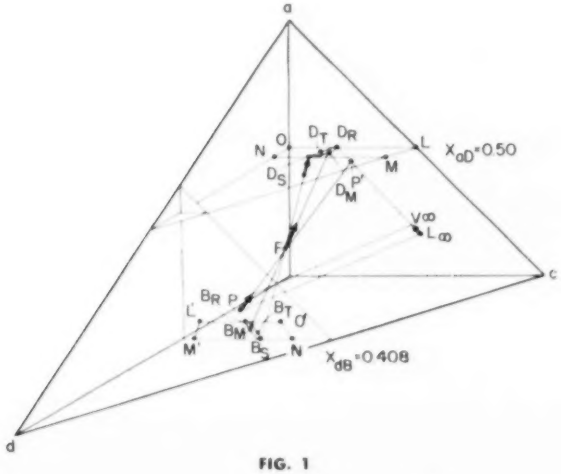



FIG. 1

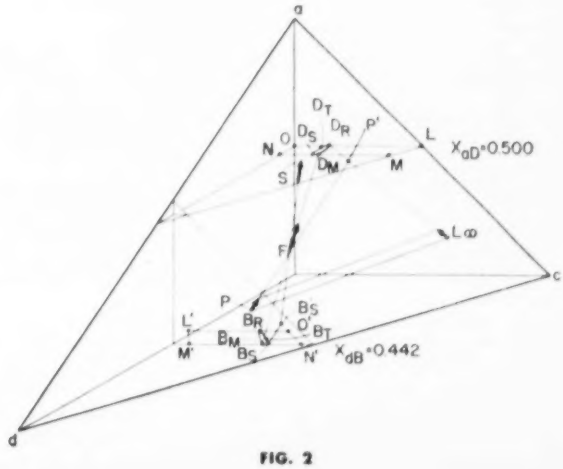



FIG. 2

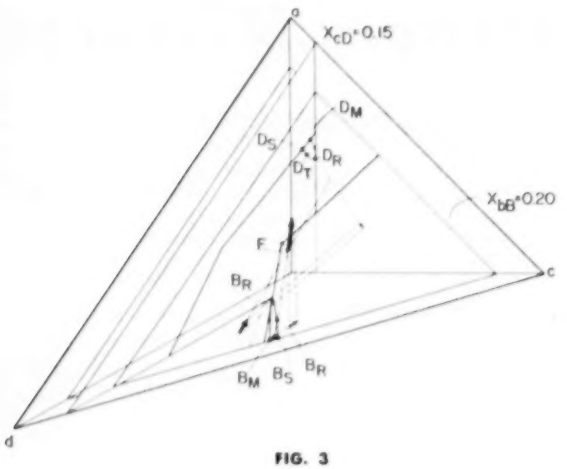



**FIG. 3**

5. Calculate $x_{bB}$, and $x_{cB}$ from $B$ and $C$.

6. Test the assumption of $x_{aB}$, Step 1 by determining whether

$$x_{aB} + x_{bB} + x_{cB} + x_{dB} = 1.0$$

Applying this procedure to the separations $x_{aD} = 0.500$, $x_{dB} = 0.408$, and $x_{aD} = 0.500$, $x_{dB} = 0.422$ determines the following compositions

| | $x_{dB}$=0.408 | | $x_{dB}$=0.422 | |
|---|---|---|---|---|
| **Component** | **Distillate m.f.** | **Bottoms m.f.** | **Distillate m.f.** | **Bottoms m.f.** |
| *a* | 0.500 | 0.061 | 0.500 | 0.039 |
| *b* | 0.328 | 0.191 | 0.346 | 0.169 |
| *c* | 0.131 | 0.340 | 0.132 | 0.350 |
| *d* | 0.041 | 0.408 | 0.022 | 0.442 |
| | N=3.8 | | N=4.6 | |

These compositions are represented by the points $D_T$, and $B_T$ in Figs. 1 and 2.

### Finite Reflux Ratio

As with ternary systems, the calculation of stage requirements and product composition as a function of reflux ratio and feed location, involves the assumption of the complete bottom (or distillate) product composition, and a checking of the distillate (or bottom) product composition calculated by a material balance with that produced from stage to stage calculations.

### Stripping Section with Infinite Stages

The tie line terminating at $y_{aD} = 0.500$ and passing through $F$, as calculated by Equation 16 of Art. No. 7[1] locates the coordinates of the point $D_S$ in Fig. 1 and the corresponding bottom product, $B_S$. The point $B_S$ lies at $x_a = 0$ so the infinite stage stripping column contains a ternary zone as well as a quaternary zone of infinite stages similar to the case shown in Fig. 1 of Art. No. 8.[1] It is clear that if $x_{dB}$ were slightly less than 0.408, only the quaternary zone would be present.

On the other hand, if $x_{dB}$ were slightly larger than 0.408, such as 0.442, the separation could not be produced in a stripping column. One limit of feed location in a complete column giving infinite stripping stages is obtained by extrapolating the ternary zone tie line to $x_{dB} = 0.442$ giving the point $B_s$ in Fig. 2. The coordinates of the various pertinent points are listed below:

| **Comp.** | $D_T$(Fig.1) | $B_T$(Fig.1) | $x_s$(ternary zone, Fig. 1) | $D_T$(Fig.2) | $B_T$(Fig.2) |
|---|---|---|---|---|---|
| *a* | 0.500 | 0.000 | 0.000 | 0.500 | 0.000 |
| *b* | 0.258 | 0.242 | 0.501 | 0.306 | 0.194 |
| *c* | 0.150 | 0.350 | 0.274 | 0.136 | 0.364 |
| *d* | 0.092 | 0.408 | 0.226 | 0.058 | 0.442 |

### Rectifying Section with Infinite Stages

As shown in Figs. 1 and 2, the tie lines originating in $x_{dB} = 0.408$ or $x_{dB} = 0.422$ and passing through the feed point do not intersect the specification plane $x_{aD} = 0.500$. Thus, it is impossible to produce either separation in a reboiled rectifying column although the products designated by points $D_R$ and $B_R$ could be produced in a column having a ternary zone of infinite stages in the middle of the rectifying section and a quaternary zone just below the feed stage. These cases are identical in principle to the preceding case for the products $D_s$ and $B_s$. The coordinates of the pertinent points are listed below:

$x_{dB}$=0.408

| **Component** | $P$ | $P'$ | $L_w$ | $D_R$ | $B_R$ |
|---|---|---|---|---|---|
| *a* | 0.125 | 0.4475 | 0.168 | 0.500 | 0.092 |
| *b* | 0.186 | 0.3515 | 0.273 | 0.366 | |
| *c* | 0.281 | 0.2010 | 0.559 | 0.134 | |
| *d* | 0.408 | 0.0000 | 0.000 | 0.000 | 0.408 |
| | L/V=0.598 | | | | |

$x_{dB}$=0.442

| | | | | | |
|---|---|---|---|---|---|
| *a* | 0.112 | 0.430 | 0.150 | 0.500 | 0.058 |
| *b* | 0.173 | 0.350 | 0.255 | 0.374 | 0.155 |
| *c* | 0.273 | 0.220 | 0.595 | 0.126 | 0.345 |
| *d* | 0.442 | 0.000 | 0.000 | 0.000 | 0.442 |
| | L/V=0.620 | | | | |

### Minimum Reflux

The minimum reflux products $D_M$ and $B_M$, are again found by the intersection of the feed tie line with the specification planes as listed below:

| | | $x_{dB}$=0.408 | $x_{dB}$=0.442 |
|---|---|---|---|
| **Component** | **Product Distillate** | **Product Bottom** | **Product Bottom** |
| *a* | 0.500 | 0.045 | 0.000 |
| *b* | 0.291 | 0.216 | 0.209 |
| *c* | 0.151 | 0.331 | 0.349 |
| *d* | 0.058 | 0.048 | 0.442 |

The range of product composition range is shown in Figs. 1 and 2. Even the relatively small change in bottom product specification of from 0.408 to 0.442 produces a sharp reduction in the range of variation of product composition. It is apparent that the closed loops indicated by Fig. 2 for $x_{dB} = 0.442$ becomes smaller and smaller until $x_{dB} = 0.50$ where the loop would disappear.

### Specification of Intermediate Components

The final example involves the specification of the concentration of components of intermediate volatility in the distillate and bottom products. This is a most important practical case since most distillation operations are conducted either to remove the lightest or the heaviest component from a mixture or to divide a complex mixture into two products, one containing so-called heavy components with very few of the light components and the other containing primarily the light components with very few of the heavy components.

For example, if it is desired to recover substantially all of component *a* in a four component mixture as a relatively pure *a*, it is necessary to specify the amount of impurity that will be tolerated in the distillate product and also it is

necessary to limit the concentration of component $a$ in the bottom product in order to limit the loss of $a$ and to insure a high recovery. This type of separation may be specified by fixing $x_{aB}$ and $x_{bD}$ at low values. In this case components $a$ and $b$ might be called the "cut" components since $a$ is passing overhead and $b$ is passing out below, the four component mixture in effect being "cut" between components $a$ and $b$. The other common case is where the cut components are of intermediate volatility such as $b$ and $c$ of the quaternary mixture. The fact that a separation may be specified in terms of intermediate cut components is what distinguishes quaternary and complex systems from ternary systems where this is impossible.

**Example:** A saturated liquid feed containing 25.0 mol % each of components $a$, $b$, $c$, and $d$ having relative volatilities of 3.375, 2.25, 1.50 and 1.0 into a distillate product containing 15.0 mol % of component $c$ and a bottom product containing 20.0 mol % of component $b$. Determine the range of product variation and the minimum reflux ratio.

**Solution:** The total reflux products $D_T$ and $B_T$ are calculated by now familiar means and illustrated in Fig. 3. The tie line terminating in $y_{cD} = 0.15$ passing through $F$ (point $P$) does meet the material balance requirement, indicating that the separation cannot be made in a stripping column. Thus the point $D_s$ was located as in previous cases of this type by extrapolating point $P$, through $F$ to $x_{dB} = 0$ and extrapolating the resulting ternary zone to $x_{bB} = 0.20$ as in Fig. 2. Similarly, the tie line originating in $x_{bB} = 0.20$ and passing through $F$, (point $Q$) does not meet the material balance requirement indicating that the separation cannot be made in a rectifying column. The points $D_R$ and $B_R$ were calculated by a manner similar to that used for point $B_s$. Finally, the tie line through the feed does not intersect the plane $x_{bB} = 0.200$ and therefore its stripping section ternary zone is extrapolated to $x_{bB} = 0.20$ to give point $B_M$. The final result is shown in Fig. 3.

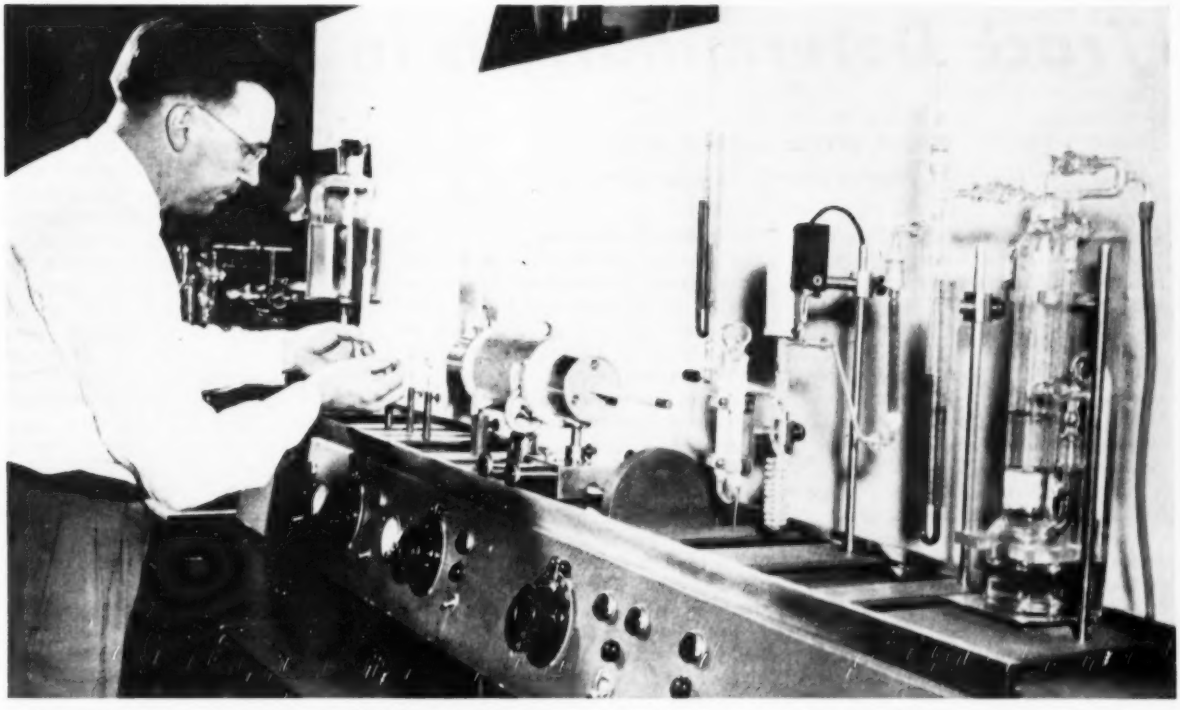
As the specifications become more difficult, the points $B_M$, $B_R$ and $B_s$ tend to move along the edges of the material balance areas towards the corner $U$. Similarly, the points $D_M$, $D_R$ and $D_s$ move towards the corner $U'$. When the point $B_M$ coincides with component $a$ completely absent and simultaneously, a pure ternary distillate product with component $d$ completely missing. This is illustrated in Fig. 3 and represents a so-called "sharp cut" separation.

#### References

(1) White, R. R., Petroleum Processing, 8, 1336 (1953).
(2) White, R. R., Petroleum Processing, 8, 1533 (1953).

NOTE: The preceding article is the final and concluding one in the series of nine by Prof. R. R. White which began in Petroleum Processing, March, 1953, p. 357, and were published to help you design fractionators.

## NEWS in VIEWS



**AUTOMATIC MICROCOMBUSTION** train for carbon and hydrogen determinations, permitting uniform burning of a sample and freeing the operator for other duties, which was designed and built by the Beacon, N. Y., laboratories of The Texas Co. Chemist Ervin Stehr, shown in the picture, designed the unit. It embodies a mechanism to advance the small electric furnace at a rate determined by the progress of the combustion. Design of the train also permits the adjustment of different units in the system and allows setting up for various analyses with the same basic equipment. The apparatus has enabled Texaco, a pioneer in the use of micro techniques, to step up its volume of analyses, and has added to efficiency in the microchemical procedures.

**COMPLETE UNIT,** including excitation source, spectrograph proper, and densitometer, used in running a . . .

# FAST SPECTRO METHOD FOR

# *Trace Determinations in Lube Oils*

***By J. T. ROZSA and L. E. ZEEB***
***National Spectrographic Laboratories, Inc.***

SERIOUS failures of Diesel engines can be avoided, maintenance costs reduced, and intervals between overhauls extended by use of spectrographic analyses of the engines' lubricating oils.

Improved techniques in the use of this instrument have been found successful on railroad locomotive Diesel engines. And, the application is obviously not limited to such engines. It can be utilized on Diesels in large trucks or in stationary installations.

The application of spectrographic analysis in this case is the determination of the amount of metal worn from engine parts and/or the contaminants causing this wear. The new instrument techniques provide a rapid and more accurate basis for interpretation.

Analyses in 25% of the previous time, for example, are possible by the development of a small rotating platform which introduces whole oil samples into the spectrograph's arc column.

Sensitivities unavailable before by direct methods have been attained by the development of a unidirectional arc excitation. As many as 17 elements can be determined with the present instrumentation and at high levels of accuracy on a wide range of petroleum products.

During the past year the validity of emission spectrographic analysis for wear product elements in Diesel engine lubricating oils has been well authenticated. The majority of the current methods [1, 2, 3, 4, 5, 6, 13, 14, 15] involve an ashing procedure for removal of the organic base and concentration of the inorganic elements. One of these methods [1, 21] has been in daily use in this laboratory for over a year with notable success. The loss in total elapsed time, the relatively high manipulation factor, the additional cost incurred by the chemical preparation, and particularly the increasing reliance of railroad engineers upon the results, has instigated a widespread search for a more rapid routine method. The popular methods [5, 12] for analyzing metallic additives are presently being reviewed and intensively studied [7, 8, 9, 10, 11] for application to the analysis of used lubricating oils.

In general, the technique employing electrodes prepared by quenching hot graphite rods in the oil sample has been found to have limited application [7]. The technique using porous cups [22], while having a greater application, is not suitable for analyzing used oils containing suspended solids [12] above one micron diameter. A third technique employing a vertical rotating carbon disc electrode, while found to be more satisfactory, is limited by sensitivity [10, 12] and increasing complexity. The optimum sensitivity reported to date has been by Porsche at about two ppm. of lead in used oils.

A complicating addition to the program was the suggested possible enlargement of the analytical program to some 30 elements although only about 10 are now of major interest. Various investigators have reported a belief that different brands of lubricating oil play an important role in normal engine rates of wear necessitating analysis of numerous additives. Also, often a combination of two elements will serve as a better indicator

of specific engine wear than a single element. It will be apparent that the application is not limited to locomotive diesel engines, but also to diesels used in large trucks and stationary installations. Similar exploratory programs have also been initiated on gasoline internal combustion engines.

**The present investigation** was an attempt to surmount these difficulties and to devise a satisfactory method for the determination of wear products and additives in lubricating oils. In addition to the methods listed, about a dozen other major approaches were made. Of them, atomization of the oil by either the fine spray hot chamber [16] or the coarse spray cold chamber [17] techniques followed by sparking was quite promising for additives but ineffective for wear products. Introduction of the whole oil into the analytical gap by several modifications of the gas transport electrode [18] produced minimum levels of detection of 1 to 5 ppm. of lead as a criteria but thoroughly lubricated the arc spark stand. The lucite cup wick feeding technique [19] performed similarly to porous cup techniques for oil. Submerged electrodes with flowing or stationary oil solutions lent added credence to the dielectric properties of oil as well as to low sensitivities.

Of all the approaches only a new technique embodying an oil tar coated platform rotating in a horizontal plane coupled with a unidirectional arc excitation was completely satisfactory. Although the method was rapid, an unusually high degree of sensitivity was obtained without sacrifice of simplicity or dependability. The overall cleanliness of the method was a distinct asset for routine work. Preliminary investigation on other applications indicated a gratifying possibility for normal solution analyses and microsegregational studies.

## PROCEDURE

Shake sample in the original container five minutes by a mechanical mixer. Weigh into flask, to the nearest 0.25 grams, the 30 grams of oil. Remove from the trip balance and titrate 6 ml. of buffer-internal standard solution from a burette into the flask. Mix thoroughly by stirring manually or mechanically. Pipette out 0.5 ml. and apply dropwise to a hot (700° F.) platform electrode. Vapor is removed and burning prevented by small 40 cfm. blower directed toward the hot plate located under a fume hood. A thin adherent tar coating should be obtained.

Set excitation source for unidirectional arc to deliver 3.5 amperes with minimum spark ignition as listed in the operating parameters, Table 1. Adjust analytical gap to 2 mm. and initiate rotation of the horizontal platform electrode. Adjust the spectrograph as listed in Table 2 and conclude exposure.

The spectral line pairings are given in Table 2. Obtain the percent transmission and calculate directly to parts per million by the conventional internal standard technique. Duplicate or triplicate exposures are recommended where higher precision is required. The results are averaged.

Synthetic standards are prepared from pure metallic-organic concentrates dissolved in pure lubricating oil. Each milliliter of the buffer-internal standard solution contains 0.15 mg. cobalt and 14 mg. lithium.

**HEART OF SYSTEM** is this rotating platform assembly, which can be easily mounted in the arc-spark stand

## DISCUSSION

**Sample Preparation**—In the analysis of used detergent type diesel oils the number of elements which may be found and the range of concentration in which they are found are dependent upon a complicated set of factors which will include the type of oil used, the composition of the engine parts, the condition of the engine, and the manner or locale in which the engine is operating.

Concentrations of these elements

### Table 1—Operating Parameters

**EXCITATION**

| | |
|---|---|
| Unit | National Spectrographic Laboratories "Spec-Power |
| Type | Condensed Arc |
| Ignition (A. C. Spark): | |
| Capacitance | 0.0012 mf. |
| Resistance | 0 |
| Inductance | 0 |
| Condenser discharge/half cycle | 2 |
| Condenser discharge voltage | 14,000 |
| Power (Unidirectional Arc): | |
| Secondary amperage | 3.5 |
| Sample | Positive |

**SPECTROGRAPH**

| | |
|---|---|
| Unit | Bausch & Lomb Medium Quartz Prism |
| Range | 1850–10,000 A. |
| Slit Width | 20 μ |
| Collimating lens aperature | 6 mm. |
| Focus | On collimating lens |
| Source to slit | 34 cm. |
| Analytical gap | 2 mm. |
| Rotation speed of platform electrode | 10 rpm. |
| Exposure: | |
| Total | 40 sec. |
| Pre-arc | 0 |
| Filter | 100/35% |

## Table 2—Analytical Line Pairings

| Element | Spectral Wavelength | Excitation Potential | Range in ppm. |
|---|---|---|---|
| Li | 6707.85 (F) | 1.84 | Internal Standard |
| Co | 3044.00 | 4.05 | Internal Standard |
| | 2286.16 | 13.65 | Internal Standard |
| | **CONTAMINANTS** | | |
| Ag | 3382.89 | 3.60 | 0.02 – 0.5 |
| | 3382.89 (F) | 3.60 | 0.25 – 3.5 |
| Al | 3961.53 | 3.10 | 0.02 – 1 |
| | 3082.15 | 4.00 | 0.10 – 6 |
| | 3082.15 (F) | 4.00 | 4 – 60 |
| | 2575.41 (F) | 4.81 | 70 – 300 |
| B | 2497.72 | 4.94 | 1 – 12 |
| | 2497.72 (F) | 4.94 | 7 – 50 |
| Cu | 3273.96 (F) | 3.77 | 0.10 – 10 |
| | 2247.00 | 15.90 | 10 – 70 |
| | 2824.37 | 5.75 | 40 – 200 |
| Cr | 4254.35 | 2.90 | 0.20 – 3 |
| | 3014.92 | 5.07 | 1 – 15 |
| | 3014.92 (F) | 5.07 | 10 – 70 |
| Fe | 2488.15 | 5.01 | 1 – 20 |
| | 2488.15 (F) | 5.01 | 20 – 200 |
| Mg | 2779.83 | 7.14 | 1 – 7 |
| | 2779.83 (F) | 7.14 | 6 – 30 |
| | 3336.69 (F) | 6.40 | 20 – 100 |
| Pb | 2833.07 | 4.40 | 0.10 – 5 |
| | 2833.07 (F) | 4.40 | 4 – 40 |
| | 2823.20 | @ 5.00 | 20 – 90 |
| | 2823.20 (F) | @ 5.00 | 80 – 400 |
| Si | 2881.58 | 5.06 | 0.40 – 10 |
| | 2881.58 (F) | 5.06 | 8 – 100 |
| Sn | 2839.99 | 4.80 | 0.30 – 6 |
| | 2839.99 (F) | 4.80 | 5 – 40 |
| V | 3093.11 | 11.09 | 0.10 – 1 |
| | 3183.98 | 3.92 | 0.50 – 2 |
| | 3183.98 (F) | 3.92 | 1 – 15 |
| | **METALLIC ADDITIVES** | | |
| Ba | 2335.27 | 11.20 | 10 – 150 |
| | 2335.27 (F) | 11.20 | 60 – 700 |
| | 2347.58 | @12.00 | 400 – 3500 |
| | 2347.58 (F) | @12.00 | 2000 – 8000 |
| Ca | 3180.52 | 5.77 | 20 – 150 |
| | 3180.52 (F) | 5.77 | 100 – 600 |
| | 3006.86 (F) | 6.00 | 400 – 2000 |
| P | 2535.65 | 7.18 | 40 – 250 |
| | 2553.28 | 7.14 | 100 – 1000 |
| | 2553.28 (F) | 7.14 | 700 – 3000 |
| Zn | 3282.33 | 7.75 | 5 – 70 |
| | 3282.33 (F) | 7.75 | 40 – 1000 |
| | **ALKALI ADDITIVES** | | |
| K | 7664.91 | 1.61 | 5 – 300 |
| | 7698.99 | 1.60 | 100 – 1000 |
| Na | 5889.95 | 2.10 | 2 – 40 |
| | 5889.95 (F) | 2.10 | 40 – 600 |

(F)—Neutral filter, 35% transmission section.

will thus vary from less than 1 to 1000 ppm. It is understandable that the form in which the wear products occur in the oils could be controversial. Observation of thousands of samples during the past year which have been analyzed permit only approximate conclusions to be drawn.

When the element is in very low concentrations it probably exists as a metallo-organic compound. When it is present in high concentrations (usually indicative of incipient future part failure) the elements may exist as discreet particles. Water is usually present. The organic form of the oil, due to heat and pressure, has undergone numerous changes. The presence of sludge is common. There are undoubtedly many industrial exceptions, but the present state of knowledge does not permit this segregational aspect to be ignored.

Hence, the initial step in obtaining a representative sample when the oil is received is to shake well. A commercial paint shaker has been successfully used to remove all sediment and layering effects prior to pipetting out the small sample.

The rotating platform technique was developed as a means of retaining the whole sample in the excitation plane after it had been thoroughly mixed; settling out of particles is therefore of little significance. The rotating platform assembly is shown in the photograph. Included is the drive motor, insulating stem, support bushing, pedestal, and graphite insert.

Various pure metal inserts into the platform were tried with success but graphite was finally chosen because of its purity, availability, and low cost. The platform electrode was machined from United Carbon's U-1 stock because of their ability to resist penetration for indefinite periods.

This latter condition was mandatory since the basis of success of liquid solution techniques is predicated upon either the lack of penetration of solution into the electrode or the uniform penetration of the solution into the electrode. Rotation of the electrode was added primarily to permit large volumes to be excited. The speed likewise is not critical, but should be consistent.

Finally, a relatively large volume of oil is placed on the electrode to foster representative sampling. This volume is approximately two to three times the equivalent amount of oil consumed by either the ashing technique or the vertical rotating electrode technique. The sample is rapidly evaporated to a thin adherent tar coating without flames. Limited spectrographic tests have indicated that the type of hydrocarbon has little or no effect upon the observed accuracy or sensitivity.

Variations in viscosity do exert a finite effect. Experimentation on samples in which the viscosity varied from 10,000 Saybolt seconds to 100 Saybolt seconds indicates inaccuracies in the 10,000 ppm range up to 20% of content. Fortunately, in Diesel lubricating oils such extremes of viscosity are not encountered and moreover in the normal low concentrational ranges encountered in wear product analysis such errors would be immaterial. For other applications where such fortuitous conditions are not present, the extreme sensitivity of the method will permit very high dilutions with the buffer solution and consequent minimization of this effect.

**Interelement Effect** — Investigation of the various oils used as diesel lubricants indicates that at least 17 different oils are currently being employed. The detergent additives to this oil type, in addition to the usual calcium, zinc barium, phosphorus and magnesium, also includes sodium and potassium.

The latter group exerts an unusually high interelement effect because of their low ionization potential. This effect may lead to serious errors in analysis. As a corrective measure, a lithium organic salt is added to provide spectroscopic buffer.

Lithium naphthenate was chosen because it can be obtained extremely pure and because lithium is not found in the Diesel crankcase Moreover, it possesses a simple spectra to avoid undue interference with analytical lines and a low ionization potential to compensate for changes in the excitation temperature of the source due

to compositional variations. The volatility of lithium is slightly on the low side, but the preponderance permits effective control to persist during the arcing period.

Unfortunately the lithium spectral lines are diffuse and exhibit erratic degrees of self-absorption. Cobalt in the form of a naphthenate is thus added as the internal standard. The excitation potential of lower energy level cobalt spectral lines is unusually suited to those of the element lines sought. While the spectral line count of cobalt is very high, the low concentrations used do not incur interference.

The use of analytical line pairings conforming to excitation potential [24] ratings is a new and theoretically correct approach to the problem of obtaining homologous lines. It is sometimes disregarded, however, in preference to obtaining close proximity of the two mated lines. Several instances of such preference have been well documented despite notable improvements in emulsion characteristics and developing machines. The bulk of these instances have been for low concentration and multiple line spectra work.

For simple spectra work such as in aluminum, magnesium, zinc, and oil the sheer availability of a requisite number of lines to complete a range is often a major problem. Under these circumstances the practical efficacy of the selection of only two or three internal standard lines to afford adequate matching has been well illustrated [29]. For high concentration work both excitation potential matching and proximity will be found mandatory for optimum accuracy.

**Excitation**—The problem of selection was predicated upon a routine application. Considerable importance was lent to the obtainment of a very low background spectrum. Since sensitivity has been a notable limited criterion for other methods, a minimum level of 1 ppm. or less was specified for all elements. Reproducibility on regular wear products as well as on the uniform synthetics was also stressed.

Variations of the alternating current spark unit in the duration of the transient discharge from six to about 200 microseconds at high power output (21 to 13 amperes respectively) were adequate, but not outstanding. The ignited low voltage alternating current arc performance was similar. The high voltage alternating current arc and the direct current arc were initially discarded because of the hazards implied in the rotation of the carbon platform disc.

The modified unidirectional arc [23] proved to be unusually suited to this problem. Background was negligible. The low amperage used, coupled with the intermittent off cycle cooling to prevent incadescent particle formation and the unidirectional aspect to minimize the heating of the upper uncoated electrode, combined to produce this factor. The alternating current spark ignition phase was maintained at a low level to reduce spectral air lines. Reproducibility was well within the 5% to 10% accuracy requirements. The secondary amperage did not appear to be critical and an increase resulted only in increased sensitivity. A wide latitude of error of manipulation was thus apparently permitted which increased its suitability for routine work.

**Sensitivity**—The sensitivities shown in Table 2 are those employed for routine operation and do not constitute the ultimate sensitivities of the method. For research work, the sensitivity may be increased by the use of a secondary lens focusing the image upon the slit, by raising the secondary amperage to approximately seven, by increasing the sample size, or by increasing the vertical aperature of the collimating lens mask. Either of these methods will normally raise the sensitivity by a factor of two.

**Spectrograph**—The choice of a spectrograph was initially predicated upon immedate availability in the laboratory. Subsequent tests on the Bausch & Lomb stigmatic 1.5 meter grating and the large quartz prism spectrographs were equally satisfactory. The sensitivity of the latter instrument, because of its ability to handle complex materials, is necessarily slower, but will provide more than adequate sensitivity.

Application to other high dispersion spectrographs in the laboratory was unsatisfactory and illustrated the need for high optical speed. This condition is not unusual since the high sensitivity of many platform electrode techniques is not predicated primarily upon the spectral line to background (signal to noise) ratio. Threshhold background is often not realized in these techniques. The major objective is to capture the maximum illumination from the arc without subsequent losses through absorption or diversion into higher orders.

In this instance the medium quartz spectrograph was unusually satisfactory since it provided both high optical speed with adequate dispersion.

**Precision**—Accuracy was thoroughly checked and confirmed by comparison to synthetic samples and by comparison to the results obtained by the routine ashing method.

In general, for values above 10 ppm., correlation was within a 10% range. For values below 10 ppm., the rotating platform technique exhibited a distinct improvement in reproducibility and a distinctly higher level of absolute accuracy.

One notable exception was found in the analysis of silicon for the 1 to 15 ppm. range. Investigation disclosed that the ashing of these oils is normally carried out in pure fused silica dishes as an important factor of economics. The presence of alkalies, either as additives or from sodium dichromate solutions leakage into the crankcase, incurs a tendency to attack the glaze of the fused silica vessels, and to produce contamination.

To minimize this effect some laboratories have made it standard practice to discard the ashing vessel when etching becomes noticeable. Contamination from muffle furnaces has also been observed. In one extreme case the degree of silicon contamination was found to be 793 ppm. The rotating platform, since it involves no ashing procedure, corrects for this irregularity. Since silica enters the oil as fine dust particles and does not apparently form metallo-organic compounds, the observed precision is accordingly lower and varies with particle size.

While the absolute accuracy was adequate, much more concern was evidenced about the repeatability from test to test. In the prediction of incipient engine failure due to excessive wear, the major criteria according to railroad engineers is a sudden change in concentration level. Two typical bimonthly series of analyses on individual engines performed in this laboratory are shown in Table 3.

Not all maintenance problem interpretations are as straightforward as

**Table 3—Typical Analyses on Individual Engines**

| Case | Element | Bi-monthly Test Number 1 | 2 | 3 | 4 | 5 | 6 | Predicted & found Incipient failure |
|---|---|---|---|---|---|---|---|---|
| A | Pb, in ppm | 3 | 1 | 2 | 18 | 13 | 28 | Main bearing |
| | Cu, in ppm | 4 | 2 | 4 | 8 | 5 | 6 | |
| B | B, in ppm | 2 | 5 | 7 | 26 | 28 | 22 | Coolant water leak at valve seat |

these two cases, but the emphasis upon concentration levels is basic. Repetitive analyses on a typical oil by several spectrographers in this laboratory over a long time period confirm the reliability of the rotating platform technique. This type of reproducibility as a criterion of precision is shown by the single determination given in Table 4.

**Analytical Aids**—In many instances the difference between a research method and a routine method is in the degree to which the method can be mechanized. The problems of cleanliness, precision, and speed are synonymous in a routine laboratory. The rotating platform technique provides numerous possibilities.

Samples of oil are obtained in one-half pint screw-type tin cans, all of a uniform size. The containers can thus be readily stacked in a paint shaker and thoroughly agitated. Testing of heavy sediment oils in the shaker, as is true of paint after long shelf storage has shown bright clean container surfaces after ten minutes of agitation.

The cost of the cans in comparison to labor cost of cleaning for re-use is slightly less and without the bulky, expensive, and dangerous cleaning equipment. The containers for the secondary sample are likewise disposable. These wax impregnated paper containers were obtained in a cone shaped form to prevent splashing and are readily adapted to a table type phosphorous shaker. A magnetic stirrer is equally satisfactory.

The amount of oil was so chosen that when two plastic drugstore-type straws are dropped into the containers, the amount of oil removed is just sufficient for loading a single platform. Repetitive uniform loading without cleaning and contamination is thus assured. The internal standard and buffer solution are pre-mixed and titrated from an automatic pipette for convenience and accuracy. A magnetic stirrer thoroughly homogenizes the standard solution before initial use.

The hot plate is small to minimize heat radiation. The electrodes are placed in sequence on the hot plate to minimize porosifying. To insure against contamination the surface has been metalized with nickel, not ordinarily found in Diesel crankcases.

The densitometer reference spectra is provided not only with an index to the requisite analytical lines, but also with three levels of impurities noted. High wear product samples are thus emphasized for special attention and notification of supervisor. The calculating board (Owens), based upon a simple slide rule arrangement, provides the results in their final form as so many parts per million ready for reporting.

**Table 4—Reproducibility**

Elements in PPM.

| Al | Cu | Pb | Fe | Si | Cr |
|---|---|---|---|---|---|
| 1.5 | 23 | 46 | 26 | 2 | 54 |
| 1.5 | 19 | 42 | 29 | 4 | 54 |
| 1.7 | 18 | 41 | 25 | 5 | 58 |
| 1.5 | 17 | 38 | 28 | 2 | 56 |
| 1.6 | 20 | 39 | 25 | 4 | 57 |
| 1.6 | 25 | 36 | 26 | 5 | 56 |
| 1.2 | 23 | 42 | 24 | 6 | 50 |
| 1.8 | 28 | 49 | 22 | 2 | 53 |
| 1.3 | 29 | 46 | 27 | 2 | 45 |
| 1.2 | 26 | 39 | 27 | 7 | 52 |
| 1.6 | 17 | 42 | 22 | 4 | 53 |
| 1.0 | 21 | 43 | 24 | 3 | 54 |

**Acknowledgment**

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## Meet the Authors

Mr. Rozsa

Mr. Zeeb

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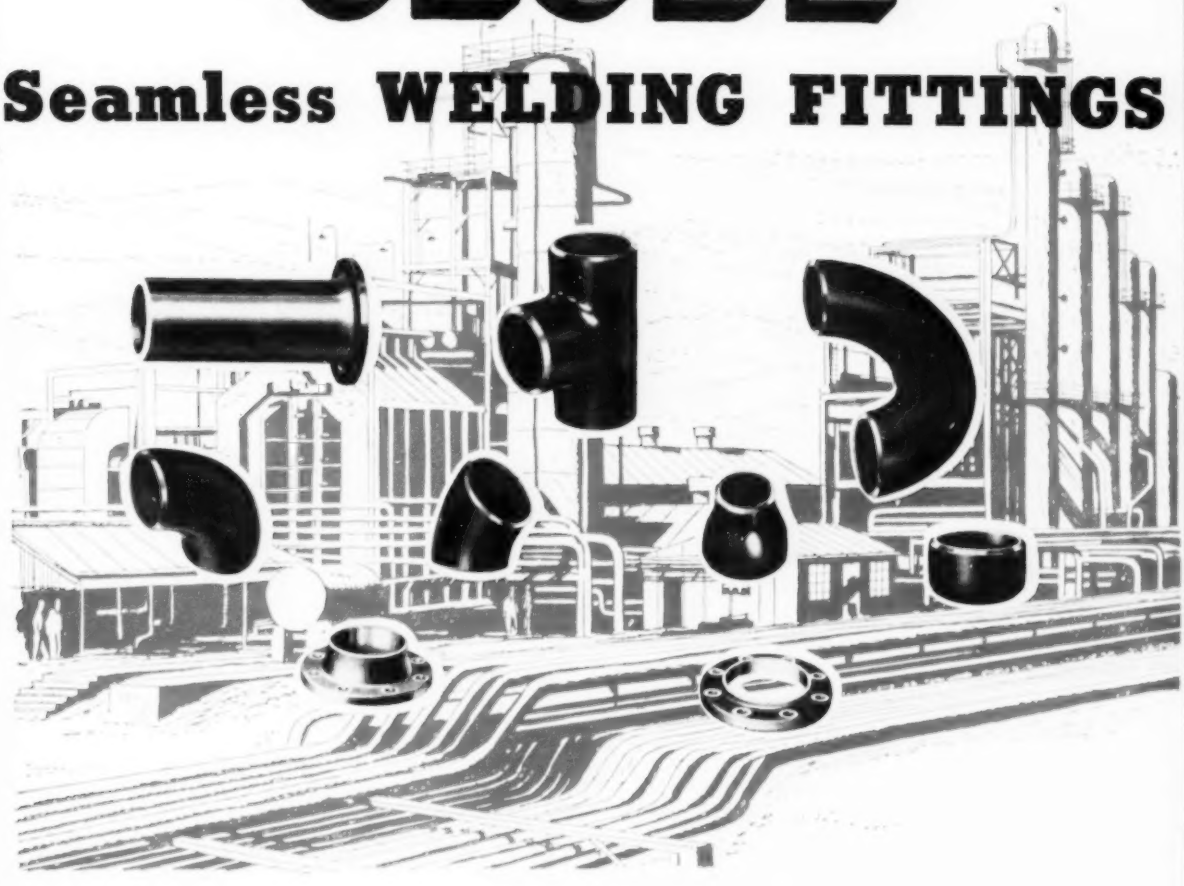

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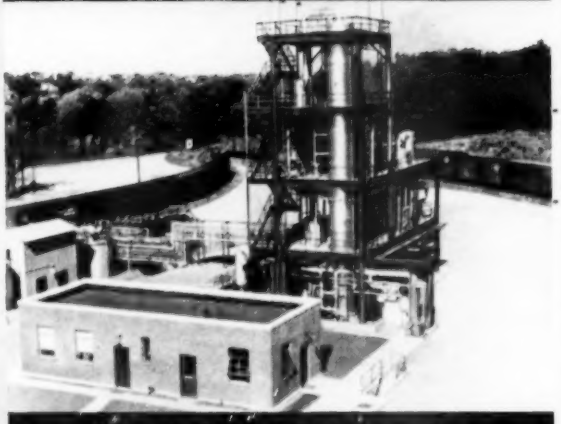

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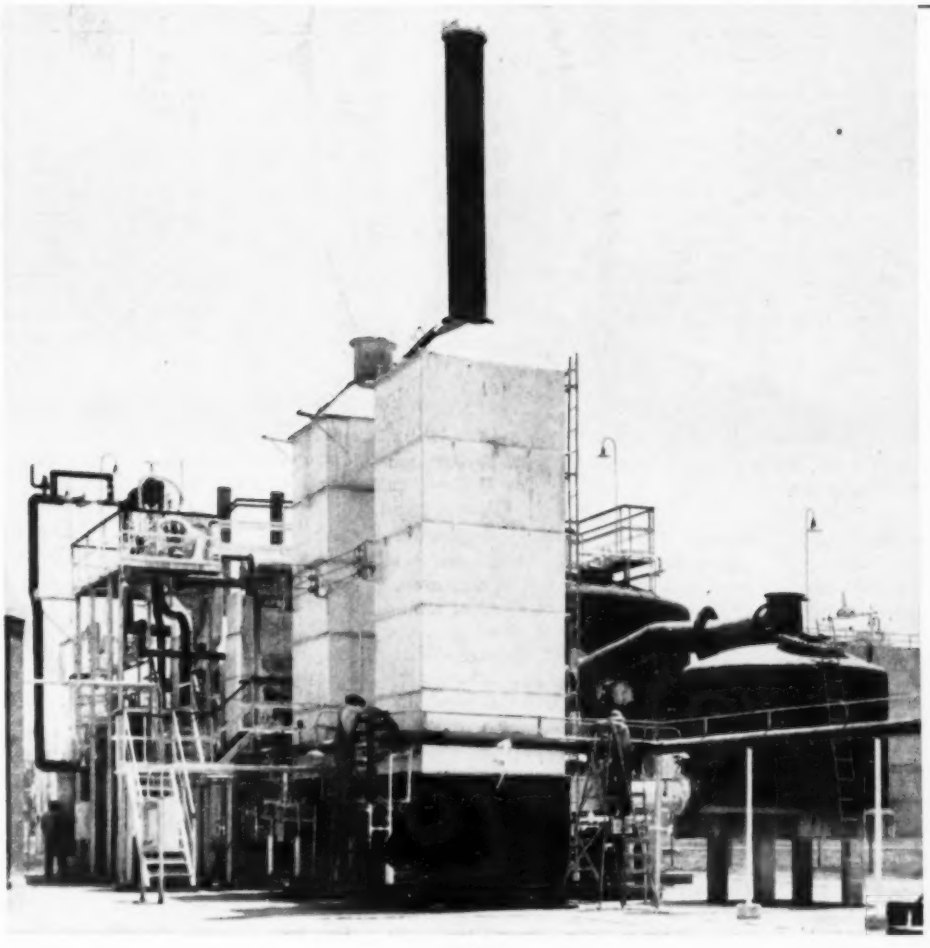

**FIRST SULFUR RECOVERY** plant of the Claus type in commercial operation in the western hemisphere was this unit at Southern Acid & Sulphur Co., McKamie, Ark.

# 'De-Bug' Your Sulfur Plant Boiler

## Avoid tube failures, heat transfer problems by knowing thermal properties of sulfur

**By SEYMOUR SCHWARTZ**
***Consulting Engineer***

IN the nine short years since the first commercial plant for recovering sulfur from petroleum-produced hydrogen sulfide was built by Southern Acid & Sulphur Co. at McKamie, Ark., in 1944, some 30-odd plants have been built in the western hemisphere.

In their rush to get into production and skim the cream from a material that has been completely wasted, refiners and natural gas plant operators encountered numerous difficulties.

Foremost problems they met were related to the removal of heat. In the beginning, sulfur recovery plants were either "burning up" or they were "freezing up." Approximately 20% of the plants built and in service since 1944 have had boiler troubles.

Many had to re-tube completely their waste heat boilers. One had to replace the entire boiler. Another small, single-unit plant started with two boilers, one of carbon steel and one of alloy construction. Difficulties were encountered by a number with various boiler types, including the two-pass, corrugated-tube type; the packaged unit; the horizontal scotch marine; the vertical tubular type; and others.

Obviously, the difficulties encountered could not possibly have been due to the type of boiler used, but must rather have been related to designs and

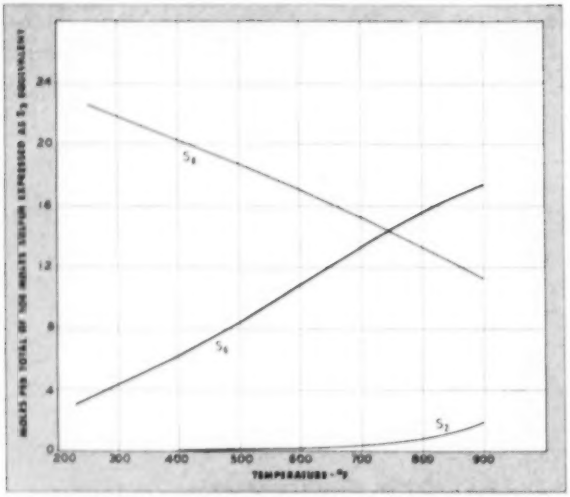


**FIG. 1**—Variation of composition of saturated sulfur vapor with temperature

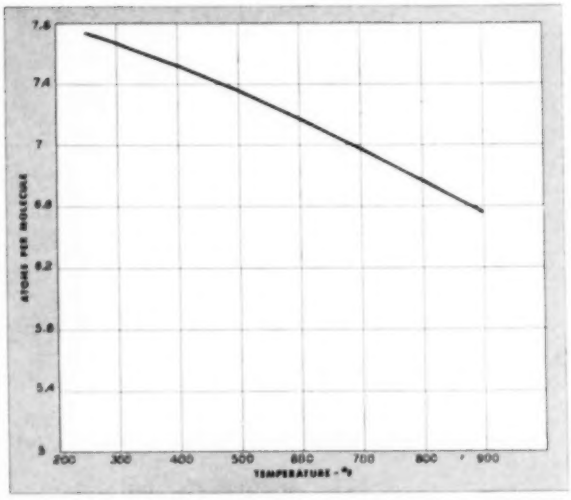


**FIG. 2**—Variation of equivalent composition of saturated sulfur vapor with temperature

the unusual conditions under which the boilers were operated.

Unsatisfactory boiler operation may be attributed to the following factors:

1—Incomplete knowledge and experience of hydrogen sulfide combustion and combustion products.

2—Incomplete knowledge of thermal data involving elemental sulfur vapor.

3—Apparently insufficient design considerations for the conditions listed above.

### Thermal Considerations

Sulfur is not a simple element, basically. Although it has been used for about 3000 years and its properties are thought to be well-known, it is in fact a complex molecular aggregate.

Stated simply, the composition of the sulfur molecule varies with temperature and pressure. The mixture consists of $S_8$, $S_6$, and $S_2$ and S molecules. (A recent publication[1] now claims the existence of $S_4$ molecules as well.) At low or ambient temperatures the $S_8$ variety predominates. At higher temperatures, the large molecules undergo dissociation into smaller aggregates and absorb heat, according to the following equations:*

$S_8 = 4/3\ S_6 - 15.61$ MBtu ..... (1)

$S_8 = 4\ S_2 - 176.94$ MBtu ..... (2)

$S_6 = 3\ S_2 - 121.0$ MBtu ..... (3)

$S_2 = 2\ S - 137.23$ MBtu ..... (4)

At temperatures above the normal boiling point of sulfur, 832° F., to about 1200° F. and at atmospheric pressure, sulfur undergoes dissociation probably according the Equations (1), (2), and (3), and the mixture is predominantly $S_2$. Above 1900° F. and dependent upon sulfur concentration (or partial pressure), dissociation according to Equation (4) is dominant, and the mixture is composed of monatomic sulfur.

The variation of the composition of saturated sulfur vapor as a function of temperature is shown in the graph in Fig. 1, as calculated from the data of Lepsoe.[2] The references to $S_2$, $S_6$, and $S_8$ represent the number of moles of such molecules per total of 100 moles of sulfur, calculated as $S_2$ for convenience; i.e., lb-moles of $S_2$, $S_6$, or $S_8$ per 6400 lb. of total sulfur.

When hydrogen sulfide combustion is carried out for the production of sulfur, the amount of oxygen required is limited by the stoichiometric amount necessary to convert one-third of the hydrogen sulfide to sulfur dioxide and water, plus complete combustion of the hydrocarbon compounds in the gas stream. The reactions are:

$$H_2S + 3/2\ O_2 = H_2O + SO_2 + 223.07 \text{ MBtu} \quad (5)$$

$$CH_4 + 2\ O_2 = CO_2 + 2H_2O + 345.16 \text{ MBtu} \quad (6)$$

The completeness of the sulfur-forming reaction, however, is determined by the rate and degree of completion of the following equation:

$$2H_2S + SO_2 = 2H_2O + 3/yS_y + Q_y \quad (7)$$

The subscript y in Equation (7) is used to denote the equivalent composition of a mixture of $S_8$, $S_6$, and $S_2$, or to denote the equivalent number of atoms per molecule of sulfur, as shown in Fig. 2. Under furnace combustion conditions, due to the high temperatures encountered, $S_2$ molecules predominate.

Therefore, for $y = 2$, heat is absorbed and $Q_y = -20.25$ MBtu. At lower temperatures, such as those encountered in the plant converters, the $S_6$ and $S_8$ species predominate. For $y = 6$, heat is evolved and $Q_y = +40.25$ MBtu. For $y = 8$, heat is also evolved and $Q_y = +46.10$ MBtu. Obviously, there is a temperature at which the heat of reaction is zero, and this occurs at about 1175° F.

### Influence of Gas Temperature

Since most sulfur recovery combustion operations are considerably above this temperature, sulfur formation leads to absorption rather than evolution of heat. In other words, conversion of hydrogen sulfide to sulfur in the combustion zone results in a lower rather than a higher flame temperature. Hence, failure to take into account decreased flame temperature results in a lower temperature difference for boiler design, and an undersized boiler.

### Effect on Boiler Duty

Two schemes are generally used for carrying out the combustion of hydrogen sulfide, each with certain advantages and disadvantages. In one, all of the acid gas stream and air is fed to the furnace, the oxygen being sufficient to convert one-third of the total hydrogen sulfide to sulfur dioxide and all of the hydrocarbons to carbon dioxide and water. In the other, only one-third of the acid gas stream is fed to the furnace with stoichiometric air, the other two-thirds being by-passed around the furnace and/or furnace-boiler.

In the first scheme, conversion to sulfur in the furnace may reach a value of 75-80% with maximum destruction of hydrocarbons in the entire acid gas stream. In the second operation, conversion in the furnace is less

* Thermal data from Bureau of Standards and other sources; pound-mole quantities; and all substances in the gaseous state.

than 20-25%, due to the fact that the reactants, $H_2S$ and $SO_2$, are not present in the required proportion of two to one. In this scheme, hydrocarbon compounds are carried into the plant converters by the by-pass acid gas stream, which may or may not foul the catalyst.

In the boiler where combustion products are cooled, two sources of heat make up the boiler duty: sensible heat in the cooling of the gas, and reaction or recombination heat. The reaction heat is caused by the recombining of smaller sulfur molecules, the evolution occurring during cooling of the combustion products in the boiler. The reactions are the reverse of Equations (1) through (4).

Since reaction heat is evolved, calculated boiler duty is in excess of sensible heat requirements. Depending upon the concentration of hydrogen sulfide in the acid gas and degree of conversion to sulfur in the combustion zone, reaction heat may be as much as 29% or more of the sensible heat duty of the boiler.

In other words, improper allowance or omission of this quantity would result in a boiler's being undersized by 29%. This factor is believed to be one of the principal reasons for undersized sulfur recovery plant boilers.

Another source of poor boiler design and operation is merely the presence of sulfur vapor in the gas stream. The conversion of hydrogen sulfide to sulfur vapor in the combustion zone results in a furnace effluent gas stream having a given sulfur dewpoint temperature. This temperature is a function of acid gas strength and conversion. With boiler tubes at temperatures corresponding roughly to saturated steam temperatures, which are generally below the sulfur dewpoints of the gas streams, it is possible for local condensation to occur on the tube surface and form a stagnant layer of sulfur around the tube. The tube may be considered to be "fouled" due to such wetted film, which cuts down on the heat transferred.

An illustration of the effect of the liquid film may be shown as follows:

Assume a single-pass, water-tube boiler operating at 100 psia. (saturated steam temperature, 328° F.) which cools sulfur-laden gases from 1900 to 700° F. Sulfur dewpoint of the gas stream, due to partial conversion, is 475° F. Let:

$U_f$ = "fouled" overall heat transfer coefficient.

$U_c$ = "clean" overall heat transfer coefficient.

$k$ = thermal conductivity of sulfur film of thickness $x$.

$\Delta t$ = overall log mean temperature difference = 832° F.

$\Delta t_f$ = temperature difference across liquid film = 475—328 = 147° F.

Now:

$$1/U_f = 1/U_c + x/k \quad \ldots\ldots(8)$$

Since the heat transferred through the liquid sulfur film equals that through the gas film, metal wall, water film, etc.,

$$(k/x)\ (\Delta t_f) = U_f\ (\Delta t) \quad \ldots(9)$$

Eliminating $(x/k)$ between Equations (8) and (9), we obtain,

$$U_f = U_c\ (1 - \Delta t_f/\Delta t) \quad \ldots(10)$$

Substituting the above values,

$$U_f = U_c\ (1 - 147/832)$$
$$= U_c\ (1 - 0.177)$$
$$U_f = 0.823\ U_c \quad \ldots\ldots\ldots(11)$$

In other words, the above conditions where a boiler tube is wetted by a condensed stagnant film of liquid sulfur due to the metal tube temperature's being lower than the dewpoint of the gas; the actual or "fouled" heat transfer coefficient is lower than the designer's "clean" coefficient by about 18%.

This calculation may be considered applicable to the condition representing 50% conversion of a 50% $H_2S$ acid gas stream. For the same terminal gas temperatures but with the boiler designed for 300 psia., the effect of sulfur fouling is to reduce the "clean" coefficient by about 8%.

As stated previously, the temperature difference across the sulfur film is essentially a function of sulfur dewpoint and boiler steam temperature. The former, in turn, depends upon the conversion of hydrogen sulfide to sulfur in the combustion zone and the acid gas concentration. Higher gas strengths and higher conversions, therefore, produce increased fouling. For 100% $H_2S$ acid gas and 70% conversion, for example, $\Delta t_f$ = 219° F., $\Delta t$ = 1020° F. and the reduction in a 100 psia. boiler is 21.5%. In a 300 psia. boiler, $\Delta t_f$ is only 130° F. and the reduction of the "clean" coefficient is only 12.8%.

The effect of sulfur fouling on the gas side is one of the many pitfalls that confronts the individual responsible for the design and proper operation of a sulfur recovery plant.

That, however, is not all. Another operating obstacle exists, which acts in the same direction as sulfur film fouling; namely, the tendency of the hydrocarbon compounds in the acid gas to break down and form carbon. When the carbon particles strike a sulfur-laden tube they stick to it and form a pasty, cement-like ring around the tubes. The relatively cooler boiler tubes are, unfortunately, at a temperature at which the sulfur is extremely viscous, "thicker than molasses in January."

With a viscosity of 6.8 cp. at 315° F., sulfur reaches a peak value of 93,000 cp. at 370° F., after which it gradually decreases. At 417° F., corresponding to 300 psia. saturated steam pressure, the viscosity of sulfur is 55,250 cp. The combination of carbon and thick sulfur is, unfortunately, an excellent insulator, and heat transfer is impaired considerably.

The difficulties referred to in this article attest to the unusual conditions which exist in sulfur recovery operations. They present a real challenge to the careful, down-to-earth designer who has to contend with economics as well.


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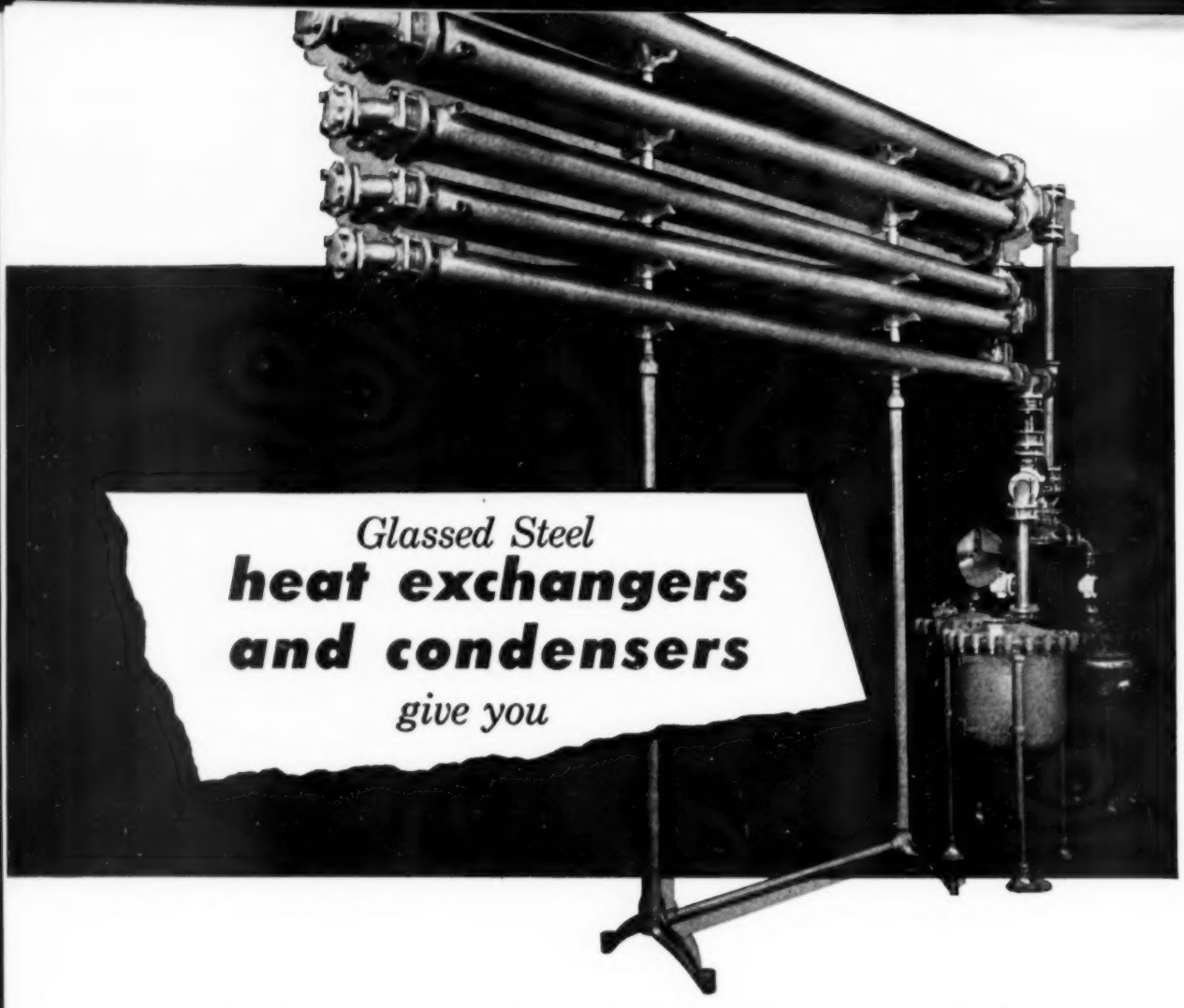
## Meet the Author

Seymour Schwartz is president of S. Schwartz & Associates, a firm of consulting engineers in New York City who specialize in the field of sulfur processing and recovery. Prior to forming his firm, Mr. Schwartz was associated with the Southern Acid & Sulphur Co. (now Mathieson Chemical Corp.) and the Allied Chemical & Dye Corp. as a technical efficiency expert with regard to design and cost reduction problems in the production of sulfur and sulfur-derived chemicals.

He received a B. Ch. E. in 1939 from Brooklyn Polytech, M. S. in 1940 from Illinois Tech, and has done additional work at the Stock Exchange Institute.



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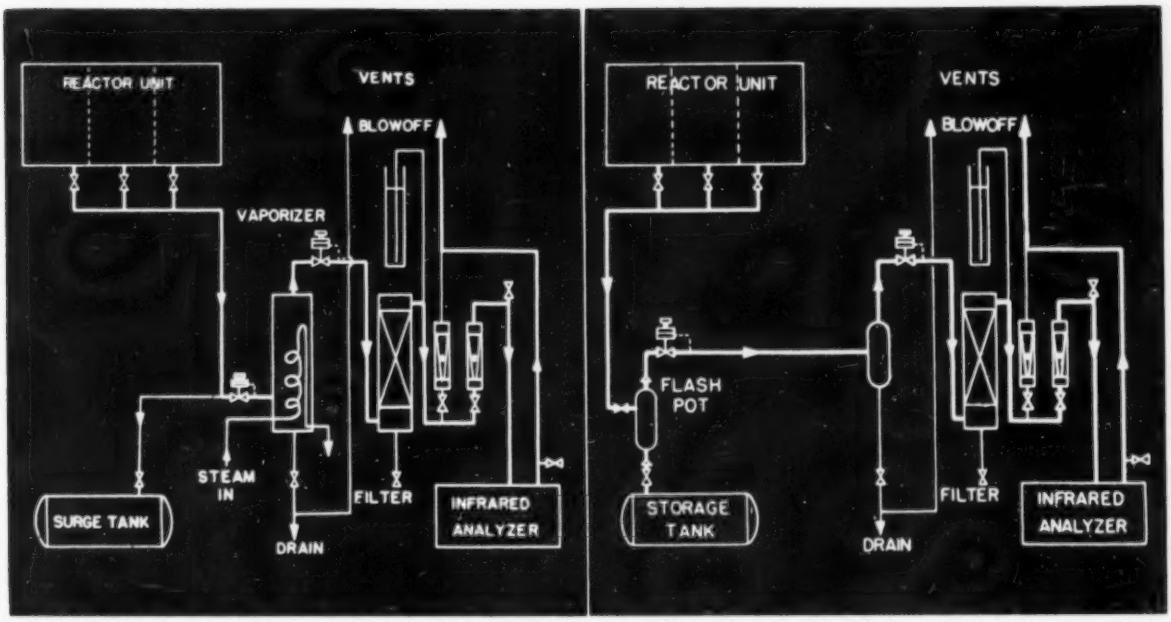



**SAMPLE SYSTEM 1**—preliminary design (left) was too complex: analyzer worked successfully but maintenance and operation proved troublesome. Final design (right) eliminated problem spots, and still gave good analysis performance

# Plant Analyzer Samplers that Work

## Three systems designed to deliver proper samples to the petrochemical process analytical instrument

ARE you installing, or planning to install, some analytical instruments on your plant processes? If so, you'll have to design and engineer very carefully, paying particularly close attention to the sampling system.

The best process stream analyzer available might turn out to be a complete failure unless the samples reaching it are both measurable and representative.

What are some of the problems to be solved in designing a satisfactory sampling system? And how can they be solved?

Seeking answers to questions like these, several hundred engineers met for a symposium on this subject during the 8th National Instrument Society of America Conference in Chicago in September.

**Specific solutions** in the design of three types of sampling systems for analyzers in petrochemical processing were given by Shell Chemical Co.'s Sherman Finneran and Frank L. Barr.

It is impossible to design a model system for all types of analyzers, the Shell men pointed out. Each installation must be considered separately and the sample system "tailor-made" to fit the individual requirements. The problems for which systems were developed were:

1—Liquid sample for infrared vapor analysis.

2—Vapor sample for infrared vapor analysis, in the presence of catalyst and hydrogen chloride vapor.

3—Liquid sample for liquid analysis from a solids-bearing stream.

A failure in the design of the first system was described and summarized because the information it provided was helpful in design of subsequent installations.

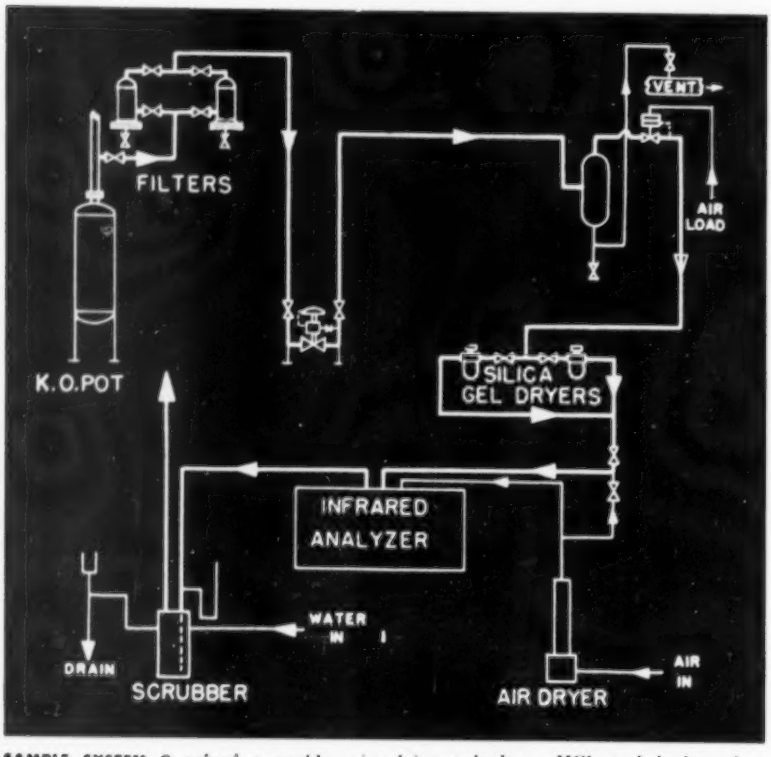
**The first sample system** was designed to take a liquid sample from the third stage of a three-stage reactor system. About 50% of the liquid sample was vaporized and about 50% of the vapor was used as a sample for a continuous recording infrared analyzer. See drawings above.

Sample connections of ½-in. pipe from all three stages of the reactor were connected through block valves to a common sample line to the analyzer panel. A liquid sample by-pass from the analyzer panel to a reactor outlet surge tank maintained a flow velocity in the sample line high enough to prevent excessive time lag.

Liquid sample at about 400 psi. passed through a spring loaded pressure reducing valve to a vaporizer. This valve maintained about 150 psi. in the vaporizer. Heat input to vaporize a portion of the sample was supplied by 50 psi. steam passing through a ¼-in. O.D. stainless steel tubing coil. A manually operated needle valve maintained a continuous liquid bleed from the bottom of the vaporizer.

A pressure reducing valve on the vapor outlet of the vaporizer reduced the pressure of the vapor to about 1 psig. Vapor passed through a glass-wool-packed coalescer to filter solids or entrained liquid. The coalescer had a mercury-sealed blow-off relief to prevent over-pressure of the sample header to the infrared analyzer flow cells.

The sample header after the coalescer was equipped with rotameters to measure vapor flow. About 50% of




**SAMPLE SYSTEM 2** solved a problem involving anhydrous HCl, and hydrocarbon vapors in presence of a sticky, solid catalyst

the vapor was measured to a vent. Remaining vapor was measured through one of two silica gel driers to the analyzer cells. The silica gel driers were piped in parallel, with suitable block valves, so they could be serviced without interrupting sample flow to the analyzer. Clear plastic bowl bubbler jars were used for the driers to assist in observation of the gel and sample.

As far as the analyzer was concerned, the sample system was satisfactory:

1—Time lag observed was about 55 seconds.

2—Sample was representative and analyzer readings checked with spot laboratory samples from the reactor.

3—Analyzer cells were protected from damage by over-pressure or from solids and liquids collecting in the cells.

**The system was a failure** because it required too much operator attention and too much maintenance. Difficulties centered around the vaporizer, but some of the other troubles were:

1—The analyzer was installed on a specially-designed graphic outside field panel to protect it from the weather and to make control of the system easy for the operator to understand and adjust. When the installation was made, the 180° return bends were accidentally left off the top of the vent lines extending through the roof of the shelter. The first rain entered the vent lines and damaged the salt windows of the sample cells.

2—The vaporizer was supposed to operate on pressure control, with level being controlled by the amount of surface of the steam coil that was submerged in the liquid in the bottom of the vaporizer. In operation, wide variations in level were experienced. The system would operate 8 to 12 hours without adjustment, so the operators had a tendency to forget to watch this level. This caused frequent shutdowns for clean-out.

3—Unexpected severe corrosion of the steam coil in the vaporizer also caused periodic shutdowns.

4—When the system was first used, the small pressure reducing valves and strainers ahead of them would plug with pipe scale that had been loosened by the flowing sample. After two months, this trouble disappeared.

**Final successful system** was developed as shown in the drawings. The vaporizer was eliminated because the sample would flash to vapor at atmospheric temperatures as low as 32° F. when the pressure was reduced to about 50 psi.

The sample header was routed to a small flash pot on top of a pressure storage tank used for residual product storage at the reactor plant. The flash pot was connected to the top of this vessel through a ½-in. pipe nipple and reducer to an existing 2-in. block valve. Vapor from the top of the flash pot is reduced to about 1 psi. by a reducing valve into a ¼-in. pipe to a knock-out pot and the coalescer at the analyzer panel.

This revised system has operated with no trouble for two years. At the same time, the time lag was reduced to about 40 seconds, and there was no change in correlation between ana-

## They Designed the Sampling Systems

Sherman L. Finneran and Frank L. Barr are the two Shell Chemical Co. instrument men whose paper from the recent ISA Conference in Chicago forms the basis of the accompanying article.

Mr. Finneran is senior engineer supervising the instrument and electrical engineering groups at Shell Chemical's Houston plant. After graduation in 1940 from Manhattan College with a B.S. in chemistry, he worked with the U. S. Navy as a phyicist on counter mine warfare methods, and then with Kellex Corp. as a physicist in the Manhattan District Project.

Mr. Finneran then joined M. W. Kellogg as an instrument engineer and sometime later became associated with Shell Chemical in the development department in New York, more recently transferring to Houston and his present position.

Mr. Barr is a construction engineer at the Houston plant. After graduation from Oklahoma A&M in 1940 with a B.S. in chemical engineering, he went with Sinclair Oil & Gas on natural gas measurement and testing work. Following this, Mr. Barr joined Chemical Construction Corp. as an instrument engineer at the Cactus Ordnance Plant, Dumas, Texas. He first became associated with Shell Chemical at Dumas as instrument foreman and engineer, later transferring to his present post at Houston.

lyzer readings and spot laboratory samples.

**An interesting feature** was the ease of calibration of the analyzer without upsetting plant operations. The analyzer was calibrated to record the percent of one of the reactants remaining after passing through the three-stage reactor. This percentage was higher in the second and first stages, so the valve to the sample header from either of those stages was opened a small amount to increase the quantity of reactant in the sample from the third stage. The analyzer reading was observed, and at the same time a sample of the vapor coming from the analyzer cells was taken for a laboratory analysis.

By proper manipulation of the sample valve, and allowing time for stabilization, a wide range of calibration points could be obtained. This method also gave an excellent method of checking the time lag of the system.

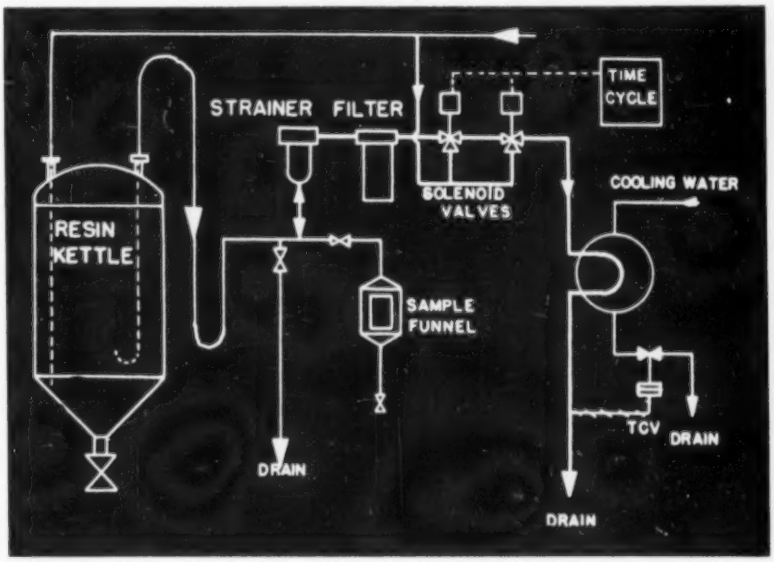
**The second sample system's** process background was as follows. Anhydrous HCl vapor and a hydrocarbon vapor were fed to a reactor together with a sticky, solid catalyst. Vapor from the reactor contained several reaction products in addition to unreacted hydrocarbon and HCl. The analyzer was calibrated to give the molecular percent of HCl to hydrocarbon in the reactor outlet.

The system is shown in the sketch. A ½-in. all-Hastelloy block valve was located in a vertical section of the vapor outlet piping of the reactor system knock-out pot.

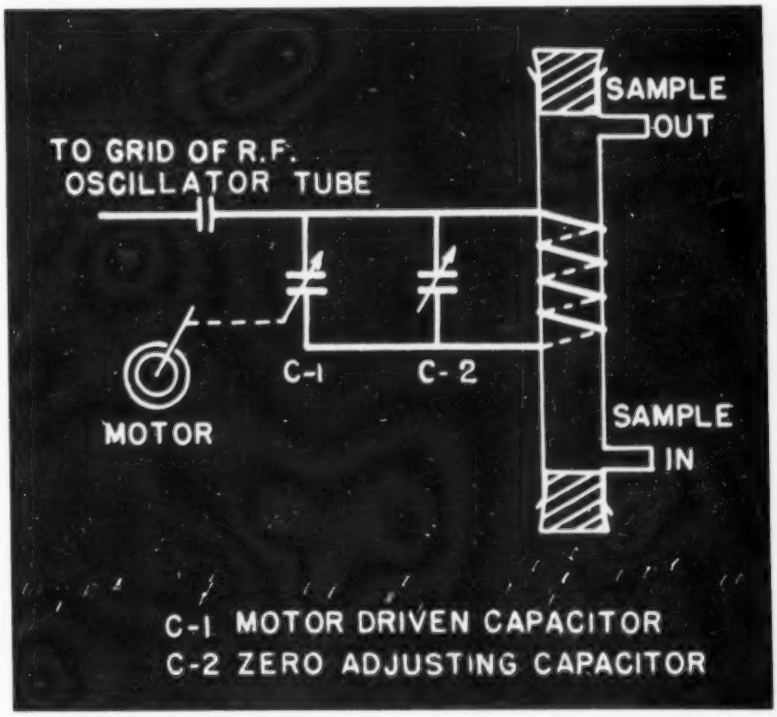
Filters were constructed of steel welding fittings and packed with glass wool. Sample entered the side through an internal pipe extending down to within 1 in. of the bottom flange. This flange was provided with a ½-in. blowdown valve. Sample impinged on the bottom, passed up at low velocity through 8 in. of glass wool and out through the top outlet. Filters were connected in parallel close to the sample block valve. Hastelloy "B" trim steel valves were arranged so a filter could be changed or cleaned without interrupting sample flow.

**Pressure of the sample system** was controlled to about 35 psi. by a ½-in. steel body, diaphragm control valve with an ⅛-in. Hastelloy "B" tapered needle valve trim, operated by a yoke-mounted pressure controller. This valve was selected to give large body clearances so that plugging by catalyst, or sticking because of corrosion, could be reduced.

Sample then passed through about 150 ft. of ½-in. steel pipe to a 4-in. diameter by 14-in. long knock-out pot. A standard instrument seal pot was used to avoid special fabrication. Sample entered this pot on the side near the top. About 80% of the sample was by-passed through the bottom of the pot to a plant vent line routed to an HCl absorber. The remaining 20% went out through the top of the pot to a special, ¼-in., "Grove," air-loaded, pressure reducing valve to one of




**SAMPLE SYSTEM 3** cured a headache caused by a resinous taffy-like material that was sticking to the analyzer electrodes




**PART OF SOLUTION** in System 3 was a change in the design of the dielectric constant recording device

two silica gel driers connected in parallel (for servicing when sample flows). Glass bowl instrument bubbler jars were used for the driers to avoid special design.

Sample then entered the infrared analyzer cells. Vapor from the cells was piped to a small Saran water scrubber to remove the HCl content before being vented to the atmosphere.

**Zero checking** was by dry air piped to the analyzer flow cell inlet. Block valves provided for by-passing the sample stream and admitting the dry air. The cell fittings were such that the dry air gave an analyzer output within the scale range of the instrument. Thus an air zero check gave a rapid indication of any drift in analyzer operation. Calibration checks were made by taking samples for mass spectrometer analysis in the laboratory.

**The original calibration** was made by changing the amount of HCl fed to the plant. The analyzer reading was allowed to stabilize at a given feed rate, and a sample of the vapor from the flow cells was taken for analysis. The same procedure was followed at several different feed rates. This gave a calibration curve over a wider range than would be experienced during any normal plant operation. The plant unit was upset for about one hour during the calibration test run.

The use of synthetic samples had been considered, but because of the relatively large volume of sample required to insure adequate purging, the plant operational test was used.

General comments on the system:

1—Very little trouble was experienced. Filters were adequate to remove the catalyst and no plugging was experienced with the filters being changed about every two weeks.

2—HCl leaks, from the packing glands of the valves in the system, were the major cause of maintenance. These were easily repaired and caused no difficulty.

3—The Saran water scrubber on the vapor from the analyzer cells would flood at intervals, requiring readjustment of the water rate. This had been anticipated and the scrubber was located below the analyzer with an overflow to a drain, so that the cells would not be damaged. A water-sealed vacuum breaker was provided on the scrubber so that water would not be pulled into the cells by absorption of HCl from the vapor in the cells if the sample flow were stopped.

4—The most maintenance was required by the filter cells and by the analyzer flow cells. Leaks would develop in the seals around the salt windows. The "O" ring seals in the cell bodies would become very hard and brittle.

5—Time lag in the system was difficult to measure. It is estimated to be about 70 seconds.

**Process background of the third sample system** was as follows. At one step in the manufacture of a synthetic resin, the resin taffy was water-washed to remove all unreacted substances. To reduce washing time to a minimum, a revised Shell Development Co. Dielectric Constant recorder was used to determine when washing was complete.

The standard instrument with a conductivity cell and electrodes could not be used because the wash water contained suspended particles of the gummy taffy which would coat the electrodes. An electrode-less flow cell was made by changing the flow cell design and the electrical connections to the instrument from a capacitive part of the circuit to an inductive part.

As redesigned, the cell was a glass tube, 1 in. in diameter by 12 in. long, with a 10-turn copper coil cemented to the outside wall. The coil was connected into the oscillatory circuit of the dielectric constant instrument. Small changes in the conductivity of the water passing through the cell changed the inductance of the coil, which shifts the frequency of the tuned circuit. The circuit was retuned automatically by a motor-driven capacitor in the instrument. The recording pen is positioned by the amount the capacitor is moved to retune the oscillator circuit.

Sensitivity of the instrument is such that 15 pp. of unreacted material will give full scale pen travel.

The sample system is shown in the drawing. It is unusual in that a time cycle controller allows wash water from the resin kettle to flow through a strainer, and a filter, and upwards through the flow cell for a short period; then by-passes this flow and backwashes the flow cell, filter and strainer with water from the wash water stream going to the resin kettle. The cycle is repeated continuously at pre-set intervals.

**Two problems** were to be solved by the intermittent operation of the sampling and measuring devices. The first was that the solids content of the incoming water was variable enough to prevent using a given chart reading as the end point for the washing cycle of the resin in the kettle. By switching frequently between incoming and outgoing water, the instrument indicates the amount of reactants being picked up by the wash water by difference. Washing the resin continues until a minimum difference is obtained.

The second problem was the removal of the taffy. With a wash water sample flowing constantly, the filters and screens would quickly clog with the material. Using a cycle of 1-minute backwash to 3-minutes wash water sample; the strainer and filter would seldom have to be cleaned except during regular plant shutdown.

To keep the two samples flowing through the cell at the same temperature, a small double-coil heat exchanger was installed immediately ahead of the flow cell. A bulb-operated temperature control valve adjusts the flow of cooling water from the exchanger.

Fully automatic, quality controlled, "pushbutton" processing plants are here now. This was the conclusion reached by the two Shell Chemical Co. instrument engineers.

Many new plant units are being designed for automatic operation with the control loops closed by quality control analysis instrumentation. Without accurate, reliable, analytical instruments, one of the greatest advantages of automatic control is bypassed.

**The need for development** of recommended practices for sampling systems is urgent. The results of an analyzer are no better than the sample received. To eliminate time lag, and extended sample systems, modern analyzers should be designed for location directly in the process or immediately beside the sample point.

Electrical or pneumatic transmitters would contribute greatly to the solution of these problems. Retransmitting slide wires may be used when transmitters are not available. Analyzers can then be used to adjust the settings of the environmental controllers.

### Other Analyzer Samplers

For more information on sampling systems for process stream analyzers, see "Two Successful Analyzer Samplers," by B. W. Thomas and R. L. Martin, Petroleum Processing, October, pp. 1511-1513. Another article on this same general subject is planned tentatively for December. Watch for it.

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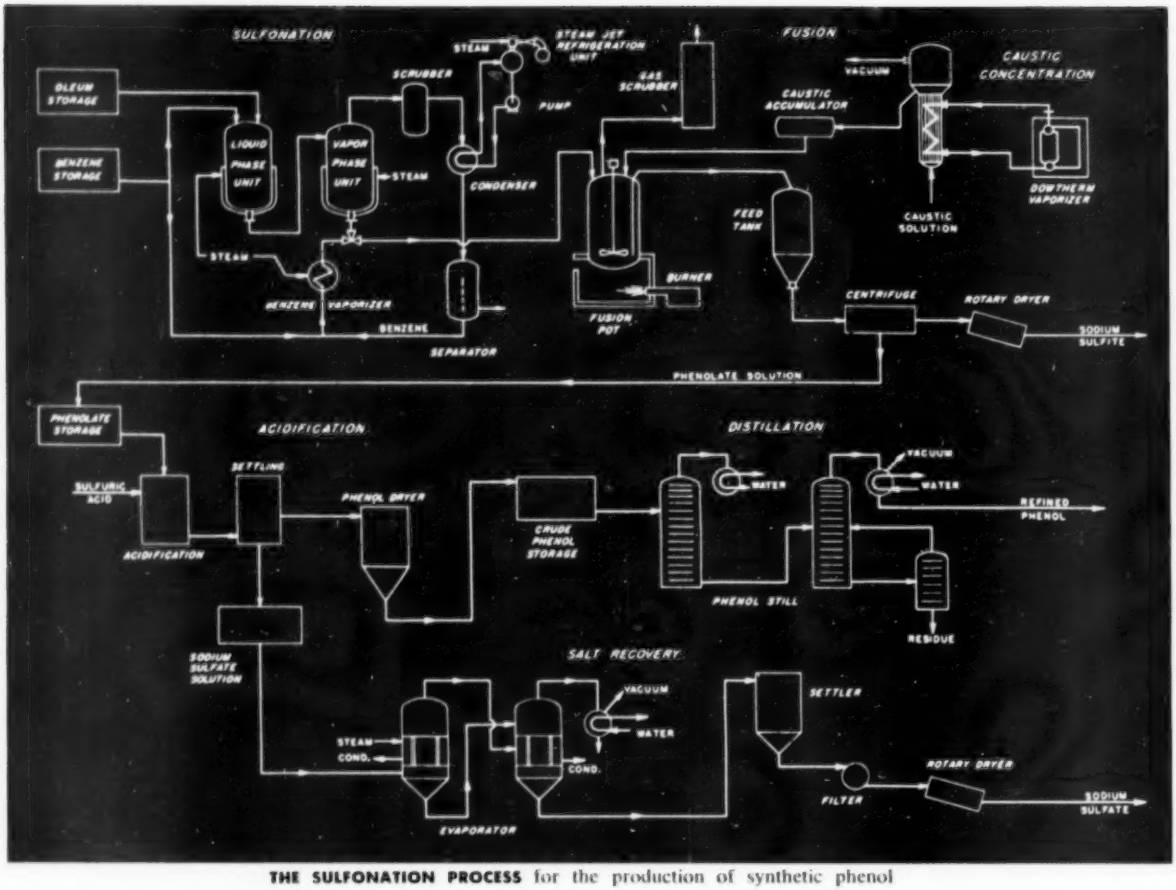



**THE SULFONATION PROCESS** for the production of synthetic phenol

# Synthetic Phenol Manufacture

## its sources, its markets, and the four major processes—cumene hydroperoxide, Raschig, sulfonation, chlorination

### Part 3—Sulfonation and Chlorination

**By PETER W. SHERWOOD**

***Chemical Engineer, New York***

THE sulfonation process for phenol production is the classical route to pnenol which has served—with changes only in detail of execution—since the beginning of the century. It offers the highest yield (on benzene) of any practicable method of phenol synthesis. Nevertheless, the process finds only limited favor today because of the large number of operating steps involved, and the high consumption of other raw materials (sulfuric acid, caustic, and—in certain versions—lime).

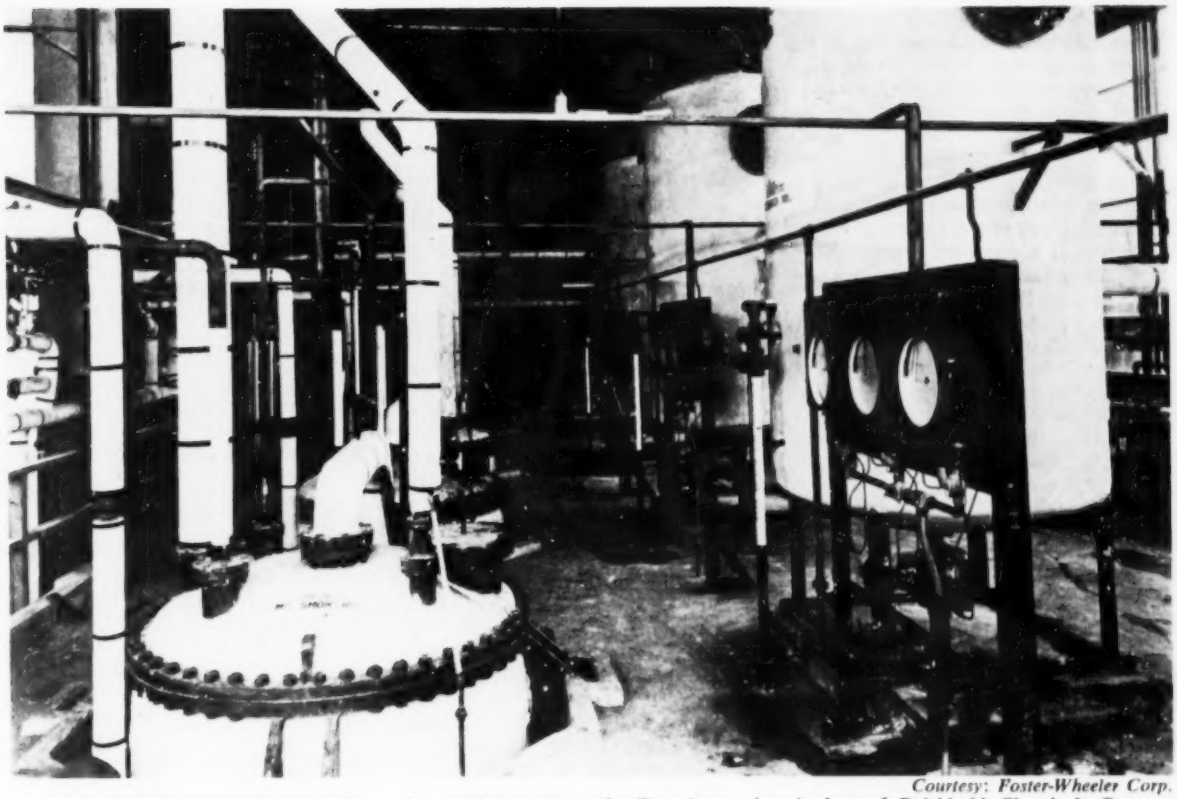
Operating economics, and low investment costs, tend to favor the sulfonation process for the production of phenol on a relatively small scale. It can be operated on a batch scale, although several American installations have now adapted operation to a semi-continuous system, with corresponding reduction in labor costs.

The process is a net producer of sodium sulfite. Ability to market this material within a freight advantage territory of the plant is of much influence on the commercial attractiveness of the process. No less significant is the local availability of sulfuric acid, and especially of caustic soda at low price.

The first step in the process is the sulfonation of benzene:

$$C_6H_6 + H_2SO_4 \longrightarrow C_6H_5{\cdot}SO_3H + H_2O \quad \ldots (4)$$

This operation which will be dis-



*Courtesy: Foster-Wheeler Corp.*

**VAPOR PHASE SULFONATORS** and caustic scrubber tanks at the Tuscaloosa phenol plant of Reichhold Chemicals Co.

cussed in greater detail below, may be carried out in the liquid or in the vapor phase. The more novel vapor phase operation has a number of drawbacks as regards yield and purity of sulfonation product. However, it is capable of utilizing sulfuric acid more effectively. The sulfonation product may therefore be charged directly to the fusion step, Equation (8), whereby residual sulfuric acid, together with benzene sulfonic acid is neutralized by caustic soda.

In liquid phase sulfonation, sulfuric acid exploitation is very incomplete. It would therefore not be economically possible to carry the sulfonation product to fusion without intervening separation of benzene sulfonic acid from residual sulfuric acid.

The first step in readying the acid mixture for caustic fusion is partial neutralization by sodium sulfite (treating):

$$2C_6H_5{\cdot}SO_3H + Na_2SO_3 \longrightarrow 2C_6H_5{\cdot}SO_3Na + SO_2 + H_2O \quad \ldots (5)$$

The amount of sodium sulfite used in treating is calculated to be the equivalent of about 85% of the benzene sulfonic acid present; i.e., only a portion of the organic acid, and none of the sulfuric acid are neutralized.

Sulfur dioxide, formed in the process may be collected and used for the springing of sodium phenate, Equation (9).

It should be noted that a principal advantage of the treating reaction is the substitution of by-product sodium sulfite for caustic soda. This operation is therefore also sometimes used advantageously to treat the product of vapor phase sulfonation, before it is led to fusion.

The partially neutralized product of liquid-phase sulfonation is now reacted with lime to form insoluble calcium sulfate. The operation is carried out in aqueous slurry.

$$H_2SO_4 + Ca(OH)_2 \longrightarrow CaSO_4 + 2H_2O \quad \ldots (6)$$

The amount of lime added to the system is slightly in excess of the amount theoretically required by the sulfuric acid present. There will therefore be formed the calcium salt of benzene sulfonic acid. This salt is water-soluble and filtration serves to separate it together with sodium benzene sulfonate from insoluble gypsum ($CaSO_4$).

Limestone (calcium carbonate) may be used instead of lime in the precipitation step. This practice has a number of operational drawbacks, but it offers the advantages of a cheaper neutralizing agent and of making available by-product carbon dioxide which may serve, in part, for the springing of sodium phenate.

The presence of calcium must be avoided in the fusion pots. It is therefore necessary to remove it from the system by ion interchange.

$$(C_6H_5SO_3)_2Ca + \begin{matrix} Na_2SO_3 \\ \text{or } Na_2CO_3 \end{matrix} \longrightarrow 2C_6H_5SO_3Na + \begin{matrix} CaSO_3 \text{ (insol.)} \\ \text{or } CaCO_3 \text{ (insol.)} \end{matrix} \quad \ldots (7)$$

In this operation calcium sulfite or calcium carbonate is precipitated. The use of sodium carbonate has the advantage of effecting more complete precipitation of calcium, but residual sodium carbonate will eventually be carried into the settlers from the fusion operation where it will contaminate by-product sodium sulfite.

Following the ion interchange, sodium benzene sulfonate is in sufficiently pure form to permit fusion. It should be noted that other organic products of the sulfonation stage (benzene disulfonic acid, etc.) are still

present at this point. However, they occur in only low concentration and are not excessively wasteful of caustic. Their fusion products are separated from phenol in the final purification steps.

The above scheme is to be considered typical of methods employed for purifying liquid-phase sulfonate prior to fusion. It is, however, not the only feasible scheme, and process design may vary in the sequence and selection of treating agents.

Regardless of the exact route selected, the purified aqueous benzene sulfonate solution is evaporated to complete or near-dryness. It is then hydrolysed with caustic in the fusion reaction:

$$C_6H_5SO_3Na + 2NaOH \longrightarrow C_6H_5ONa + Na_2SO_3 + H_2O \quad \ldots (8)$$

The product of the fusion pots is dumped into dissolving tanks containing sulfite washing liquor from a previous batch. Sodium phenate will go into solution while by-product sodium sulfite may be removed by settling and by filtration. The inorganic salt is washed on the filters and is dried, ready for use elsewhere in the process and for sale, while the washings are collected for use in the dissolving tanks of the fusion stage.

Sodium phenate is acidified with sulfurous, carbonic, or sulfuric acid, ("sprung") to yield free phenol:

$$C_6H_5ONa + H^+ \longrightarrow C_6H_5OH + Na^+ \quad \ldots (9)$$

As has been explained above, carbon dioxide and sulfur dioxide are available from other stages in the process and may be used to achieve most of the springing. If $SO_2$ is used for this purpose, additional amounts of recoverable sodium sulfite are formed.

In small plants, where sulfur dioxide recovery is not practiced, sulfuric acid may be used for the springing step. Such practice results, of course, in increased raw materials consumption.

During acidification most of the phenol will separate from the aqueous phase. Residual dissolved phenol can be recovered from the aqueous layer by extraction (ethyl or n-propyl ether, or benzene). Distillation serves for final purification of the product.

The many steps involved in this process make it impossible to give in this paper, detailed consideration to the operation requirements for each. Attention will therefore here be confined to the most important stages which are characteristic of phenol production via the sulfonation route.

**(a) Sulfonation of Benzene:** In the classical, liquid-phase sulfonation, benzene is added to 100% sulfuric acid at a rate which is controlled by the ability of the reaction vessel's cooling coils to remove the exothermic heat of reaction and to maintain the temperature substantially constant at 60-75° C. The use of stronger acid (i.e. oleum) promotes the formation of yield-consuming sulfones, as does addition of benzene at higher temperatures.

By raising the temperature, it is possible to use sulfuric acid more efficiently. More benzene is added to the system than the 100% acid is capable of converting at 75° C. After the entire benzene charge has been added to the reactor, the batch temperature is therefore raised to 100-105°C to complete the reaction.

In accordance with universal practice, I. G. Farbenindustrie Leverkusen[16] uses cast-iron sulfonators. At this plant, 1100-gal. jacketed vessels are employed, provided with propeller-type 80-rpm agitators. A quantity of 8300 lbs. 100% sulfuric acid is weighed into the reactor and 3300 lbs. benzene is added in the course of one hour. The reaction may have to be initiated by raising the temperature to 60° C. Once it has taken hold, however, it is allowed to rise to 75° C where it is maintained throughout the addition period by passing cooling water through the jacket. Following addition, steam is turned into the jacket and the temperature is taken to 105° C where it is held for four hours to complete the reaction.

The operation can be worked on a semi-continuous basis by using three or four sulfonators in series. The first kettle serves for addition at 75° C, while the remainder are used for finishing up at a higher temperature. Such an approach permits considerably greater throughput per unit reactor volume and reduces labor requirements.

Water is a by-product of sulfonation with sulfuric acid. The acid strength is therefore decreased as the reaction progresses. It has been shown by a number of investigators that the rate of sulfonation declines as the acid becomes more diluted. Eventually, a point is reached where further sulfonation can no longer take place, regardless of temperature, degree of agitation, etc. In the case of benzene sulfonation, this state is reached when the concentration of sulfuric acid has dropped to 66.4%.

Since the tendency to sulfone formation limits the permissible initial $SO_3$ concentration to about 82% (i.e. to 100% $H_2SO_4$), the depletion of sulfonating power at 66.4% $H_2SO_4$ makes it necessary to use very large amounts of excess acid. Indeed, only 55% of the available $SO_3$ is utilized if 100% sulfuric acid serves as starting material. The acid waste increases rapidly if the initial concentration is taken at a lower value.

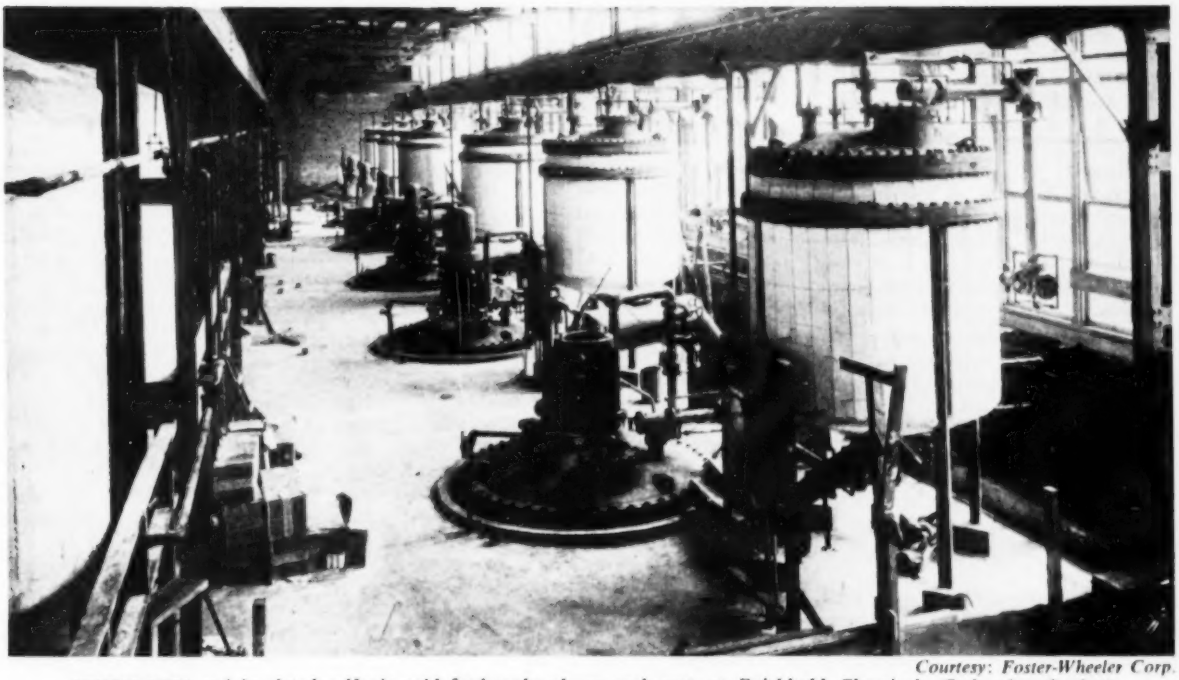
In the case of liquid-phase sulfonation the amount of residual sulfuric acid in the product is of such magnitude that it must be separated from the benzene sulfonic acid before fusion becomes economically (and mechanically) possible. A scheme to effect such separation has been outlined above.

An alternative approach is to maintain a high sulfuric acid strength throughout the sulfonation step by the continuous introduction of $SO_3$ or by the removal of water. The former scheme has been described in the literature but is defeated by the formation of very large amounts of sulfones—probably due to excessive local $SO_3$ concentrations. The continuous removal of water from the reaction system is being practiced commercially in the United States (e.g., Reichhold Chemical's Tuscaloosa plant, and at Monsanto Chemical Co.'s St. Louis installation).

Possible methods for the removal of water include the application of high vacuum to the sulfonators. Benzene is taken overhead together with water.

The route chosen in commercial practice involves the removal of by-product water by azeotropic entrainment with benzene. ["Vapor phase" sulfonation processes of interest include those developed by Tyrer [17], Ambler[18], Guyot[19]] A slightly different route is taken in a process due to Kokatnur[20], in which the sulfonation is carried out in a high-boiling hydrocarbon oil from which water is removed azeotropically as it is formed.

Planovskii and Kagan[22] have described a continuous method for carrying out the vapor-phase sulfonation developed on a batch system by Tyrer and others. In this operation, liquid benzene is fed to a sulfonator vessel containing recycle benzene sulfonic acid together with sufficient make-up sulfuric monohydrate to raise the total $H_2SO_4$ content to 30%. The feed to this sulfonator is continuous and the overflow is fed to the top of a seven-plate tower in which the reaction mass is contacted with ascend-



*Courtesy: Foster-Wheeler Corp.*

**FUSION POTS** and insulated sulfonic acid feed tanks above each pot at Reichhold Chemicals Co.'s phenol plant

ing benzene vapors. Operating temperature in the tower is 180° C.

Benzene, together with azeotropically entrained water vapor, leaves the top of the column. After condensation, the benzene is recycled to the primary sulfonator. Leaving the base of the column is the reaction product containing mainly benzene sulfonic acid together with some 3-4% unconverted sulfuric acid and sulfones which are formed in the process. A portion of this stream is recycled to the sulfonation step where it serves as carrier medium for make-up sulfuric acid. The remainder is withdrawn as sulfonation product to be subjected to the subsequent required steps in the phenol synthesis process.

Diphenyl sulfone formation in this process is claimed to be quite low (about 3-4%). It should be noted, however that work by other investigators does not bear this out. Harvey[23], and more recently Boehme[24] have reported that diphenyl sulfone formation and disulfonation reduce overall phenol yield (on benzene) to 60-70% if vapor phase sulfonation is used. This compares with a 90% overall yield by the classical (excess acid) method which is carried out in the liquid phase.

Commercial selection of the sulfonation process must be based on a balance of cost factors inherent in the lowered yields vapor phase method and in the increased sulfuric acid and lime consumption and the more complicated after-processing scheme which are called for by liquid-phase sulfonation. Both schemes are still in industrial service.

Mention should be made in this connection of the Dennis-Bull method of sulfonation which has the advantages of high yield and good sulfuric acid exploitation. In this process, benzene sulfonic acid is extracted from the spent (liquid-phase) sulfonation product by means of benzene in which it is about 2% soluble. The spent acid, substantially free of organic material, is refortified by means of $SO_3$. Benzene is removed from extracted BSA by topping and is recycled. Commercial application of this process is, however, defeated by the large amounts of benzene which must be circulated, and the correspondingly low thermal efficiency and large equipment requirements.

**(b) Processing of Benzenesulfonic Acid:** We have outlined above the steps which will render sodium benzene sulfonate in sufficiently pure form to permit its introduction into the fusion pots. The chemistry of these operations is quite straightforward. Most of the processing difficulties are mechanical in character (e.g. production of a filterable gypsum, adequacy of washing the fiter cake, etc.). However, the operations are in no way peculiar to the production of phenol, and detailed discussion in this place is not necessary.

It should be emphasized, however, that the excess acid (liquid-phase) method of sulfonation requires the separation of residual sulfuric acid from the organic product by conversion to the calcium salts in aqueous medium. Insoluble calcium sulfate can then be removed from the soluble calcium benzene sulfonate.

This step is not necessary in the treatment of the product of vapor-phase sulfonation. Since this stream contains only 3-5% sulfuric acid, it is economically feasible to convert it directly to the sodium salt by treatment with sodium sulfite or with sodium hydroxide. The presence of sodium sulfate in the feed to the fusion pots creates a problem of sodium sulfite contamination which is practically non-existent in the production of phenol involving liquid phase sulfonation.

**(c) Fusion of Sodium Benzene Sulfonate:** The conversion of sodium benzene sulfonate to sodium phenolate is brought about by high-temperature reaction with caustic soda, in accordance with Equation (8). The operation is carried out by batch methods in all plants for which information has become available.

The fusion process is illustrated by the practice at Monsanto Chemical Co.'s St. Louis, Mo. phenol plant.[25] Both reactants are introduced as concentrated aqueous solutions. Caustic soda is first fed to the fusion pots as 70% solution. Here it is heated and evaporated to near-dryness. Once the caustic has become substantially an-

hydrous (at a temperature slightly above 300° C) concentrated sodium benzene sulfonate solution is pumped above it and is mixed into the mass. The rate at which NaBS is added to the fusion pots must be carefully matched to the rate of heat input to prevent hardening of the mass. After all the organic salt has been introduced, the fusion mixture is retained in the pots for some time to permit the reaction to go to completion.

The finished fusion batch is discharged to dissolver tanks containing water which has served to wash sodium sulfite filter cake from a previous batch. This medium is substantially saturated with regard to sodium sulfite and also contains some sodium phenate. The resulting slurry of sodium sulfite in sodium phenate solution is separated by centrifugation.

Monsanto's fusion pots are vertical cast-iron kettles with anchor-type agitators and dished-up bottoms which impart the desired mixing motion to the reaction mass. The kettles are set in brick and are heated externally by natural gas or oil.

The plant at Leverkusen, Germany, [26], uses substantially the same approach to fusion. Cast-iron 1500-gal. fusion pans are employed, provided with an anchor-type agitator (20 rpm) and a bottom valve for draining off the product.

In preparation for a batch, 975-gal. 50% sodium hydroxide solution is preheated to 280° C and is then fed to one of the fusion pots. Here it is heated to 320° C whereby it is simultaneously dehydrated. 12,500 lbs. powdered, dry sodium benzene sulfonate is then added to the batch in the course of four hours. During the addition period, temperature is maintained at 315-325° C. It is then raised to 335-340° C over a period of 1.5 hours.

Upon completion of the reaction, the melt is discharged to a quencher tank containing aqueous sulfite washings. The resulting slurry is separated by filtration.

**(c) Springing and Purification of Phenol:** After separation from sodium sulfite, the sodium phenolate solution is contacted with sulfur dioxide (or, in at least one instance, with carbon dioxide). Acidification is not complete but is sufficient to produce a crude phenol phase which separates from the aqueous sodium sulfite slurry. Most of the unconverted sodium phenolate is dissolved in the phenol phase.

Following phase separation, neutralization of the organic layer is completed by means of sulfuric acid. The crude phenol is finally washed with a recycle water stream and is then ready for distillation.

The various aqueous streams withdrawn in the course of this springing and washing operation may be extracted with an aliphatic ether for the recovery of contained phenol.

The distillation system of Monsanto Chemical Co. consists of three sets of bubble-plate columns. The first two act as dehydration units. The aqueous stream from the first column contains 10-15% phenol and is recycled to the acidification tank. With a phenol concentration of 75%, the overhead from the second column joins the crude phenol feed.

The bottoms from the secondary column enter the final still in which U.S.P. phenol is taken overhead, ready for flaking and sales. The bottoms from this column are worked up in a residue still.

At Leverkusen, where a similar three-column arrangement is used, the first still is operated at atmospheric pressure, while the other two are run at 20-25 mm. Hg. abs. Residue is worked up by steam distillation.

### The Chlorination Route to Phenol

Capacity-wise, the direct chlorination route is the most important method for the synthesis of phenol. The process consists of two fundamental chemical stages:

$$C_6H_6 + Cl_2 \xrightarrow[FeCl_3]{} C_6H_5Cl + HCl \quad \ldots (10)$$

$$C_6H_5Cl + 2NaOH \longrightarrow C_6H_5ONa + NaCl \quad \ldots (11)$$

As in the sulfonation process, the sodium phenolate is readily converted to phenol by acidification.

In this method of phenol synthesis, chlorobenzene serves as intermediate. As we have seen, this is also the case in the Raschig process. Unlike the latter, however, the direct chlorination route is non-regenerative and requires the use of chlorine and caustic, as well as benzene. The resulting greater raw materials costs are counterbalanced by the effects of a much higher per-pass conversion which is possible in direct chlorination. It wil be recalled that both chemical steps of the Raschig process are limited to a conversion (per pass) of 10-15%, and that this results in very high utilities consumption as well as in relatively large process equipment requirements.

**(a) Production of Monochlorobenzene:** The chlorination of benzene is carried out in the liquid phase. The effect catalyst is ferric chloride which may be, if desired, produced in situ from iron turnings, etc.

Care must be taken to minimize overchlorination. Outlets for polychlorinated benzene are quite limited. The principal organic by-product —paradichlorobenzene—finds certain applications as moth repellant, etc., but its formation, too, must be repressed.

Advantage is taken of the more favorable chlorination rates of benzene as compared to its chlorinated derivatives. Furthermore, it is possible to favor chlorobenzene formation by maintaining a reasonably high benzene: chlorobenzene ration in the reactor—i.e. by taking incomplete conversion per pass.

The outstanding effect of conversion level on monochlorobenzene yield is illustrated by data due to MacMullin.[27] Thus, if one mole of benzene is reacted with 0.2 moles chlorine (at 55° C), practically the entire reaction product is monochlorobenzene. After 0.5 moles chlorine have been added to the batch, formation of polychlorinated benzenes has risen to 6% of the total benzene-free product. Maximum monochlorobenzene formation (but not yield) occurs when 1.07 moles chlorine have been added per mole benzene. Ultimate monochlorobenzene yield at this stage is 81% (on benzene). Overchlorination above this ratio results in rapid yield reduction.

This effect of chlorine: benzene ratio is even more pronounced in continuous operation, and batch chlorination is quite commonly used in commercial practice. Favorable to monochlorination is the use of low temperatures. Here, the limitations are set by reaction rate considerations and by available cooling water temperature.

From the foregoing it should not be concluded that batch chlorination is used to the exclusion of continuous operation. The continuous system is feasible if relatively small conversion per pass is taken or if the manufacturer finds adequate markets for by-product polychlorobenzenes. Furthermore, the design of the reactor is of significance in the yield of monochlorobenzene which can be achieved. Wiegandt and Lantos[28] have shown that particularly good performance can be obtained if a long thin tube is used as continuous chlorinator.

Continuous chlorination was used at General Electric Co. at its Pitts-

field, Mass., phenol plant.[29] The reaction was carried out just below the boiling point of benzene. The liquid effluent from the converter reportedly contained 55% unreacted benzene, 42% monochlorobenzene, and 3% dichlorobenzenes. After neutralization (by means of caustic), the product was separated by distillation.

Another continuous chlorination operation is carried out at Hoechst, Germany.[26] Each reactor consists of two legs made of an inner steel tube (app. 2¼ in. diameter) which is surrounded by a steel jacket for water cooling. Each leg of the reactor is about 9 ft. long. The thoroughly dried reactants are fed to the reactor in the ratio 3.3 lbs. benzene:1.8 lbs. chlorine. After upward passage through one of the two reactor legs, the material enters a collector box from where part of it is withdrawn, while the remainder continues downward through the second leg and joins the incoming feed stream at the bottom of the unit.

Ferric chloride is added to the collector box at the top of the reactor. Feed rate is approximately 0.1% of the benzene flow. Chlorination temperature is maintained at 60-70° C. Ratio of recycle benzene to make-up is about 1.0.

At these conditions, formation of dichlorobenzene is quite high. The product leaving the reactor collector box has the following approximate composition: 48.5 wt.-% benzene, 36.5 wt.-% monochlorobenzene, and nearly 15 wt.-% dichlorobenzene. This corresponds to an ultimate monochlorobenzene yield of 76% of theory. By comparison, General Electric Co.'s process, which appears to have been operated with a much higher benzene recycle ratio (1.8 vs. 1.0 in the Hoechst process) is said to have shown a monochlorobenzene yield of nearly 95% of theory.

At Hoechst, a rough cut is made between benzene and chlorinated derivatives by topping. The crude chlorinated cut is neutralized and dried before fine distillation. By separating benzene prior to neutralization, redrying of this stream can be avoided.

Illustrative of batch chlorination, which is capable of achieving high monochlorobenzene yields, is the process carried out at Leverkusen.

The cast-iron chlorinator is provided with internal cooling coils. To it are charged 2500 gals. caustic-dried benzene and 33 lbs. ferric chloride (note that ferric chloride promotes the corrosion of iron equipment. Many plants have therefore taken to the use of metallic iron in addition to or in lieu of ferric chloride).

*Previous installments in this series of articles on the manufacture of synthetic phenol appeared in: September, pp. 1348-1354, and October, pp. 1543-1545.*

Chlorine is introduced into the chlorinators until the desired specific gravity is reached. Where monochlorobenzene is the only desired product, this is in the range of 1.06-1.1. Reaction temperature during the reaction is maintained at 20-30° C. Batch time is in excess of 10 hrs. and depends on the degree of chlorination. (This is a long reaction time as batch chlorinations go, and it is set by the available cooling facilities. It has been shown that formation of a high mono:dichlorobenzene ratio is favored by short chlorination time.)

The chlorination product is fed to a brick-lined neutralizer where it is contacted with an aqueous sodium hydroxide solution. Sufficient time is provided to remove labile chlorine atoms which have reacted by addition rather than substitution. Unless this precaution is taken, there is danger of hydrogen chloride formation in the subsequent distillation step.

The amount of residual benzene is relatively small (about 15-20% of the reactor effluent). This is topped off and returned to chlorination. The crude chlorobenzene fraction is worked up by vacuum distillation.

Equation (10) shows that hydrogen chloride is evolved in the course of the chlorination reaction. This is usually first scrubbed by means of chlorobenzene (or a crude mixture of chlorinated benzene homologues), in order to recover entrained organic material. HCl is then absorbed in water in a conventional absorber built of karbate, ceramic, silica, or other acid-proof material. It is important to note that steel or iron serve satisfactorily in the construction of the reactor proper in which the system is maintained free of water.

Hydrochloric acid recovered in the chlorination section of the plant finds internal use in the acidification of sodium phenolate to form phenol.

**(b) The Hydrolysis of Monochlorobenzene:** This reaction, Equation (11), is carried out in the liquid phase. To permit the required conversion temperatures in the range of 370-400° C, operation is at pressures in excess of 4000 psi.

Caustic is supplied as an aqueous solution of 10-15% strength. Operation calls for a caustic excess of approximately 10% above theory.

In one plant, typical of the process, the feed to the reactors consists of 2000 volume parts 15% sodium hydroxide solution, 396 parts chlorobenzene, 60 parts phenyl ether, and 70 parts phenolate liquor. This represents a caustic:chlorobenzene molar ratio of approximately 2.2. Phenyl ether, which is formed in the process, must be recycled to repress further formation of this product, which would otherwise be heavily yield-consuming. Some phenolate liquor is introduced with the feed to remove dissolved oxygen which interferes with the reaction.

The thoroughly mixed feed is pumped against a pressure of 4000-4500 psi. to a heat exchanger where its temperature is raised to 280-300° C in exchange with reactor product. It is finally boosted to 390° C in a gas-fired preheater.

The reactor proper is a nickel-lined chamber sized to permit a hold-up time of 15-20 minutes. It has been shown that the overall reaction rate is only slightly temperature-dependent above 350° C. Below 325°C, however, required contact time rises rapidly.

The effluent from the reactor passes through the feed-vs.-product heat exchanger and is finally water-cooled to 60-70° C. It is then released to atmospheric pressure.

This phenolate liquor now passes through a settler where phenyl ether is skimmed off, to be stored for recycle. The alkaline aqueous phase is contacted with n-propyl ether containing phenol from a subsequent stage in the process. In this extraction, phenol enters the aqueous phase while residual diphenyl ether passes into the organic layer.

After separation of the phases, the solvent is removed from phenyl ether by distillation. N-propyl ether is returned to the purification stages while a portion of the phenyl ether is recycled to the reactor.

The aqueous raffinate, containing sodium phenolate, which leaves the primary extractor, is now acidified. Hydrochloric acid is available as byproduce from benzene chlorination and is commonly employed for this step. However, dilute sulfuric acid will serve this purpose as well. The choice of acid must be determined on the basis of locally prevailing economic considerations.

During the springing, phenol will separate from the aqueous phase to form a distinct layer. This crude phe-

nol is subsequently purified by distillation.

The partial solubility of phenol in water makes it necessary to recover residual product from the acidified aqueous phase by solvent extraction. N-propyl ether serves as a useful solvent in this operation. The extract is recycled to be contacted by alkaline phenolate liquor, as mentioned above. In this operation, phenol is carried into the aqueous phase on its way to the springing step.

Crude phenol, which has separated out during the acidification is purified in a series of stills. Dehydration is carried out at atmospheric pressure. The final purifying distillation is a vacuum operation. Bottoms from this stage are worked up in a residue still which is also operated at vacuum.

Saleable by-products of the direct chlorination route to phenol are principally dichlorobenzes, diphenyl, and diphenyl oxide. The available markets for these materials determine in a large measure the operating details at various stages of the process. Thus, as has been mentioned, production of polychlorobenzenes can be raised by reducing the amount of benzene recycle or by boosting the temperature in the chlorination unit. Diphenyl oxide formation is controlled by the amount of recycle taken through the hydrolysis reactors.

If diphenyl ether is not sold, and recycle is taken, the overall yield of phenol has been reported to be about 85% (based on monochlorobenzene). Failure to recycle diphenyl oxide results in a reduction of phenol yield to about 78-79% of theory.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# Do You Know These Words?


**By B. H. WEIL**
***Manager, Information Services***
***Ethyl Corp. Res. & Engrg. Dept.***
***Detroit, Mich.***


*A regular department intended to help administrators and operating men alike keep abreast of technical names and processes in the petrochemical field.*

### Dodecylbenzene

**Dodecylbenzene,** pronounced "doe-**dess**-ihl-**ben**-zeen," is the petrochemical which has largely been responsible for the rapid replacement of soap by synthetic detergents. It is a fairly colorless liquid, slightly lighter than water, and it boils at much higher temperatures than does the latter. It has the formula, $C_{12}H_{25}{\cdot}C_6H_5$.

Dodecylbenzene is produced by the reaction of dodecene and benzene in the presence of a catalyst. Either coal-tar or petroleum-derived benzene may be employed, while the dodecene used is normally a predominantly $C_{12}$-hydrocarbon fraction obtained by the polymerization of propylene.

For the production of alkylaryl sulfonate detergents, of which dodecylbenezene sulfonate is the leading product, dodecylbenzene must be sulfonated. This reaction is conducted either by companies which produce dodecylbenzene and also market finished detergents, or by producers of detergents who perform only the sulfonation step. The finished detergents also contain quantities of sodium sulfate, carboxymethyl cellulose, and certain polyphosphates. Because of these important "builders," only one-third to one-half of a pound of dodecylbenzene sulfonate is required to replace one pound of soap in heavy-duty detergent powders.

Both of the chemical intermediates used in the synthesis of dodecylbenzene are themselves petrochemicals. Benzene is being extracted in increasing quantities from catalytic reformates, while the propylene required for dodecene synthesis is obtained either from refinery gases or by deliberate cracking of propane.

Although the growth curve for dodecylbenzene is showing some signs of leveling off, as other detergents rise in importance; new uses for this material have been stimulated by its low cost and ready availability. The future will almost certainly see its sulfonate used to an increasing extent in household specialties and in industrial applications.

### Methio..ine

**Methionine,** pronounced "meh-**thigh**-oh-neen," is one of the 10 or 11 amino acids (building blocks for proteins) which are essential in the diet for the normal growth of animals. It is also a petrochemical in every sense of the word, for, while its synthesis is complex, it is based on several chemicals which are derived from petroleum or natural gas. A fine white or buff-tinted powder, with a waxy texture and a characteristic odor, methionine has the formula, $CH_3\,SCH_2\,CH_2\,CH\,(NH_2)\,COOH$.

It may be obtained by the hydrolysis of natural proteins, but commercially it is synthesized (in one process at least) by the reaction of acrolein with methyl mercaptan, the addition product then being further reacted with sodium cyanide and ammonium carbonate. Further steps involve reaction with sodium hydroxide and, finally, with hydrogen chloride.

While methionine is only one of the 19 amino acids which occur commonly in the feed proteins used for poultry and animals, extensive tests have proved that it is one of the most critical and that the addition of free methionine to such feed (perhaps one pound per ton) is highly profitable in terms of increased unit growth. In addition, methionine finds use in the manufacture of certain pharmaceuticals.

Of the chemical intermediates used in the synthesis of methionine, acrolein is derived from the petroleum gas propylene, and methyl mercaptan is synthesized by the reactions of mercaptans (from petroleum refining) with methanol (derived chiefly from natural gas). Hydrogen cyanide (for sodium cyanide) and ammonia (for ammonium carbonate) may both be prepared from natural gas and atmospheric nitrogen, while carbon dioxide (the other material for the synthesis of ammonium carbonate) can be made by combustion of natural gas or petroleum. Hydrogen chloride can also be obtained from by-product hydrogen from petroleum refining.

Few petrochemicals enter directly into human or animal food as does methionine. Increased production of the material is definitely anticipated.

**SINGLE OPERATOR** bungs up and seals as automatic . . .

# One-Man Unit Fills 1000 Drums per Day

STANDARD of California has developed what it calls the world's only completely automatic drum filling machine.

The unit enables one man to fill 1000 drums (55-gal. size) in a single eight-hour day. Standard has been using it for lubricating and other oils, but it can handle almost any type of liquid.

The filler specializes in the 55-gal. drums. Although these come in several types, varying in weight, height, and position of the bung hole; the machine compensates automatically for such variations.

Standard has had the equipment in use for several months at its Richmond, Calif., refinery and has licensed the Rucker Co., Oakland, to manufacture the drum filler.

The machine as installed costs $25,000. But because it can be operated by one man, it can pay for itself in about 20 months, according to an economic study by Rucker. It would take 3½ men to fill 1000 b/d with ordinary equipment. Therefore the machine saves the labor of 2½ men each day. Estimating payroll at $4200/man/yr., the annual saving would be $10,500.

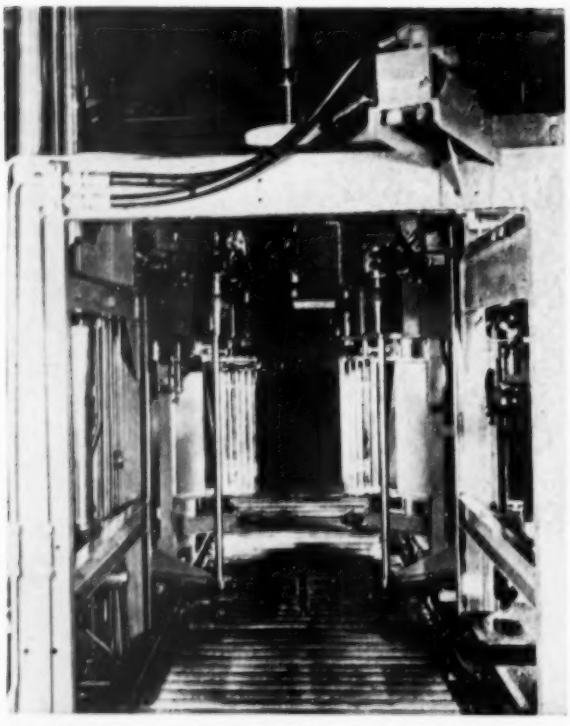
Another saving of $22,100/yr. is estimated on overfills. Rucker estimated an average overfill of 1 lb./bbl. with the machine, as compared to 2 lb. in a manual operation.

Gross savings come to $32,600/yr. after $200 is deducted for maintenance expense. However, an income tax of 55% must also be deducted, making the net annual savings $14,670.

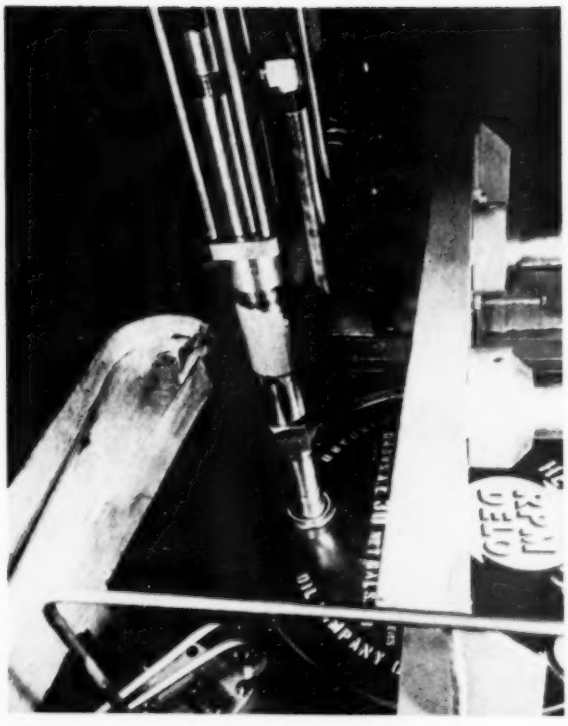
**How the filler works** — A bung-locating device is the first station on the conveyor line. Actuated by hydraulic cylinders, the rollers feed empty drums into this station, one at a time. At this point, vertical rollers come to bear on the top chine of the drum. First they hold it in place, then they rotate it slowly.

Meanwhile, an overhead carriage lowers to the top of the drum. In it is a finger which rides over the top of the drum as it rotates. When the bung comes into a position on the centerline of the conveyor, the finger drops into the hole. This action sends a signal through the control circuit to halt the rotating motion and to open a gate admitting the drum to the next operation—filling.

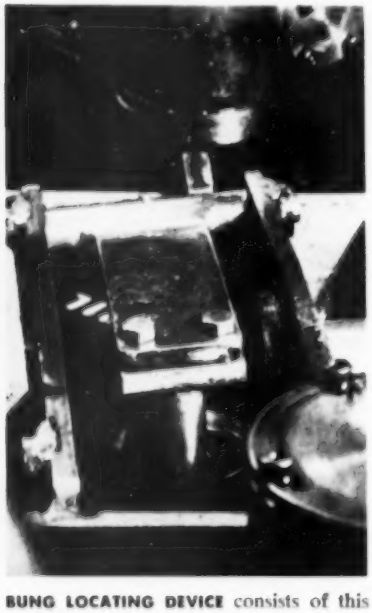
**The filling operation** — The drum then moves down the conveyor line to the second station, which is the filling scale. As soon as the drum is in position on the scale, the overhead carriage rises and retracts to its



**POSITIONING MECHANISM** consists of vertical rollers which rotate drum until bung-hole reaches proper filling location



**FILLING LANCE** inserted into drum during filling operation. Drip pan (at left) swings under lance when it emerges



**BUNG LOCATING DEVICE** consists of this "finger" which drops into hole and signals rollers to stop

original place at the first station, ready to work on the next incoming empty drum.

A sensitive scale automatically computes the tare weight of the drum. Then a filling lance lowers into the bung-hole, and when it approaches the bottom of the drum, it starts flowing oil.

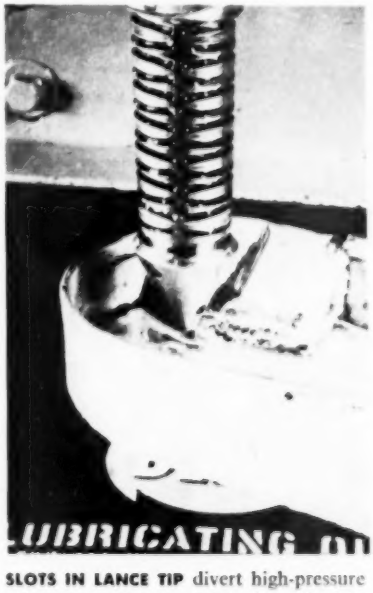
Filling the drum at the rate of 225 gpm., the lance is quickly submerged and stays that way until the drum is filled, cutting down on foaming. Another feature of the lance is a spurt-diffusing head to prevent the scale from weighing the force of this stream of incoming oil.

**Automatic cut-off** comes in two steps. First, when the scale reaches a point just a few lbs. short of the proper net weight, flow rate is dropped to a trickle. Then, when the correct net weight is reached, flow is cut completely.

The lance then withdraws from the drum and, as it reaches the top of its stroke, a drip pan automatically swings below it to keep the drum tops clean.

Filling is so synchronized with bung-locating that when the drum has been filled, the next drum on the line has been rotated into position. The positioned drum then is moved down by the conveyor rollers, pushing the filled drum off the scale. Capping is not included in the mechanism.

**Several safety devices** are contained in the machine to prevent spillage or machine damage in the event of interruptions in power supply or other emergencies.




**SLOTS IN LANCE TIP** divert high-pressure oil stream and prevent scale from "weighing" velocity of oil

First, if the supply of empty drums is interrupted, the machine will proceed only with the drum being filled, then wait for more empties. When empties reach it, the machine resumes filling automatically.

Second, if the "finger" can't locate

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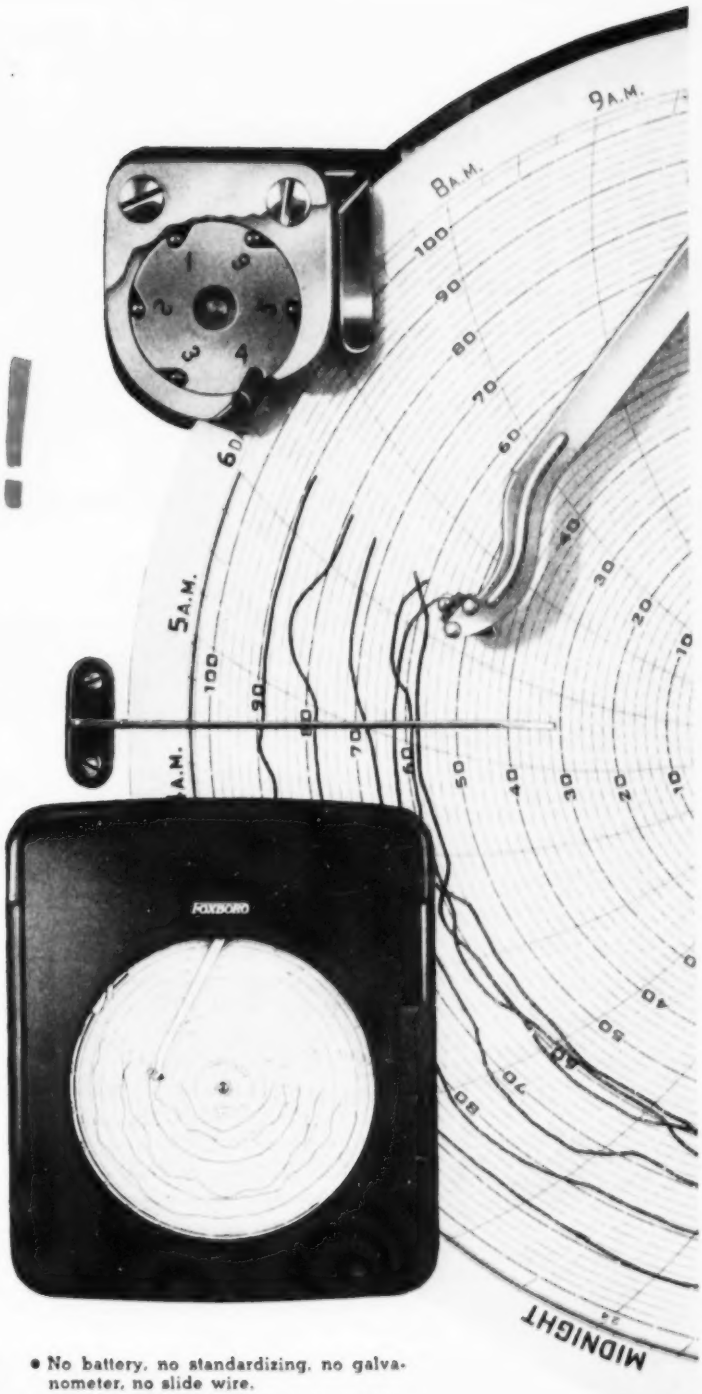


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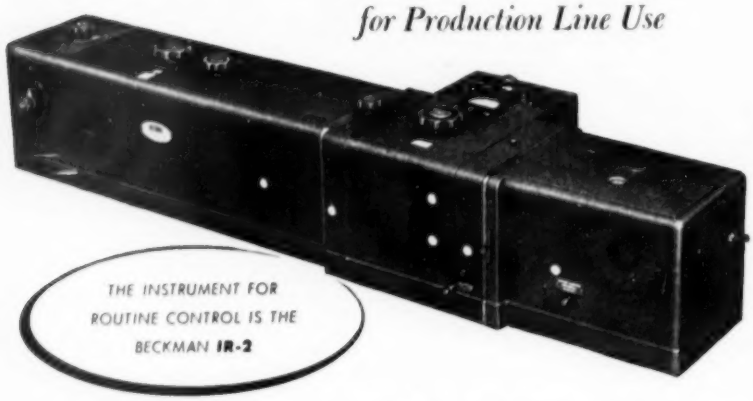


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the bung, the drum will continue to rotate until the operator spots the trouble and takes care of it. The carriage pushing mechanism cannot operate until a bung is located.

Third, if the power fails, no liquid can flow.

**A multiple-lance system** has been developed to accommodate a variety of types or grades of liquid. Otherwise, it would be necessary to disengage and clean the lance before changing from one type of oil to another, causing lost time. A multiple-lance arrangement allows for selection.

For short runs, for which it is impractical to use the fully automatic filler, another model has been developed—a semi-automatic drum filler. Drums are set in place manually and the operator starts the filler by pushing a button.

## Tips on Maintenance Of Ball Bearings

AN important part in the service life of an electric motor or a pump is played by shaft bearings. Proper fit, installation, and lubrication are all important factors in obtaining good service.

In last month's "Plant Practices," a series of questions and answers dealing with fitting the bearings on the shaft were presented. They were a portion of a seminar on this general subject conducted at the Aruba, Netherlands West Indies, refinery of Lago Oil & Transport Co. by Mr. Jack Cannon of Continental Electric Co., and made available to PETROLEUM PROCESSING by Lago.

The problem of fitting in the housing is covered in this month's series of questions and answers:

*How do you fit the proper internal looseness of a tapered roller bearing?*

This is usually done with shims between the faces of the outer race and the bearing housing.

*What kind of fit do you give the outer race of a bearing in a pump housing?*

A drop-fit.

*What effect does the temperature of the pump shaft have on the bearing fit in a housing?*

If the pump shaft runs hot because you are pumping a hot liquid, then you expand the inner race because it becomes hot. The balls transmit some of the heat from the inner race to the outer race. If you start with a drop-fit, you will finally get a thumb-

push-fit when you are operating. If the pump shaft is going to run cold because you are pumping a cold product; then the inner race will shrink because it has become colder and, in turn, the outer race will shrink. In this case you should start with a tap-fit of the bearing in the housing, and wind up with a thumb-push-fit when you are operating.

*Will a drop-fit cause the outer race to turn in the bearing housing?*

No. If there is so much friction between the balls and the inner and outer race tracks to cause the bearing to turn in the housing, then you do not have enough internal looseness. A bearing as tight as this will generate terrific heat and have a very short life.

*Suppose a bearing is too loose in the housing when it is running, what happens?*

Usually the outer race will vibrate in the housing or it will pound. This is not good, because it will shorten the life of the bearing and cause a fatigue failure.

*Isn't a drop-fit of a bearing in the housing too loose? Won't it cause vibration?*

No. When you are assembling a bearing or shaft into a housing in the shop, everything is at the same temperature. However, when the pump or motor is finally installed on the job, you want the various fits to be proper when the pump or motor is running under a load. Because heat will flow from the pump shaft into the inner race of the ball bearing and then through the balls into the outer race, you get an expansion of the outer race that you did not have in the shop. You must allow for this expansion beforehand. The play you had with the drop-fit will disappear under operating temperatures.

*Why doesn't a bearing housing expand with the outer race of the ball bearing?*

In most pumps the bearing housings are cooled with water. Therefore they do not expand. In motors, the fan on the out-board end is cooling the bracket and housing with air so that they do not expand as much as the bearing. On the in-board end of most motors, the cooling air is directed against the bracket and bearing housing which again does not permit it to expand as much as the outer race of the ball bearing.

*Should the fit of the bearing be the same for both housings of a motor or a pump?*

Yes, unless some very unusual condition is present.


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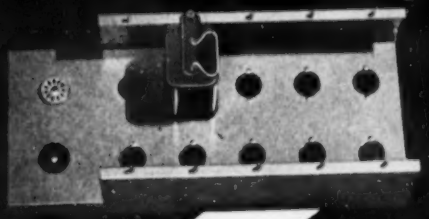

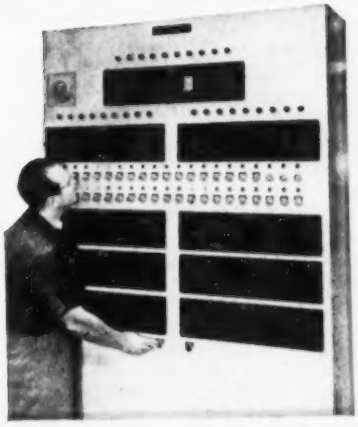

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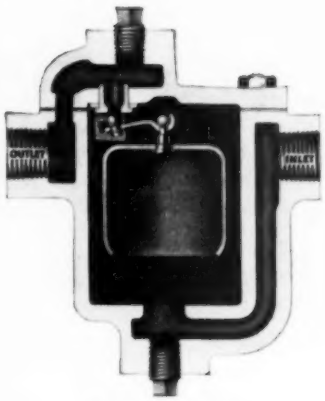
**Model 70-TD** for pressures to 150 P.S.I. and temperatures to 375° F. is available WITH BUILT-IN THERMAL BY-PASS at additional cost.



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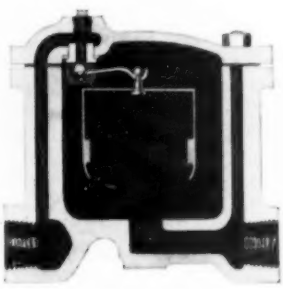

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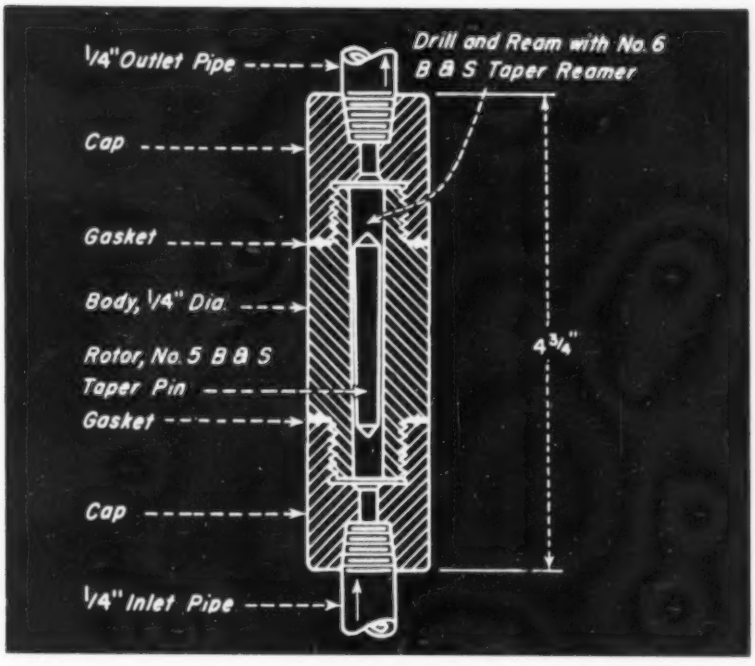


## Valve Double-checks Bottle Gas Flow

TROUBLE is frequently encountered when compressed gas is being used from a cylinder, because of sudden changes in the pressure downstream of the cylinder.

A sudden increase in the downstream pressure will force material backward into the cylinder. A sudden decrease in this pressure, such as would result from the rupture of a safety disk, will cause rapid loss of the gas.

To eliminate these difficulties, personnel at du Pont's Penns Grove, N. J., laboratory, have designed a simple, inexpensive check valve. (See drawing.) The valve consists of a tapered vertical passageway containing a pin of somewhat smaller diameter and corresponding taper. The pin has conical ends which conform to a seat at either end of the passageway.

When gas flow is at the desired rate, the pin floats in an intermediate position. Any reversal of pressure will force the pin downward against the conical seat at the lower end of the passageway. This will prevent backward flow of material.

A sufficient decrease in downstream pressure will cause the pin to be driven upward against the seat at the upper end of the passageway. This will block the flow of gas from the cylinder.

A valve having the dimensions given in the illustration, when used at 50 psig. to 100 psig., will allow gas to pass at a maximum rate of 210 standard cu. ft./hr., but will close when the rate exceeds this value. At 1500 psig., the valve will allow gas to pass at a maximum rate of 900 standard cu. ft./hr. The valve may be adapted for various pressures and maximum rates of flow by altering the weight of the pin or the clearance between the pin and the wall. Because of its simple design, the valve may be constructed from a wide range of materials.

## How to Seal Ground-Glass Joints

**By G. K. CHADD**
**Chief Chemist**
**Cosden Petroleum Corp.**

THE problem of sealing ground-glass joints under high vacuum in the presence of hydrocarbon vapor, or liquid, at high temperatures (mentioned in the May issue, p. 733) has been a challenge for years. Cosden Petroleum Corp. has had very good results using a lubricant material prepared in the laboratory of the Big Spring, Texas, refinery.

The material consists of a mixture of chemically pure glycerine and cracking catalyst, prepared as follows:

Screen to 275-mesh, or preferably to 325-mesh, a quantity of commercial grade catalytic cracking catalyst, containing a substantial percentage of aluminum oxide. Mix this powder with the glycerine to a thick paste and use as the stopcock grease.

The material has been satisfactory in hydrocarbon distillation equipment at temperatures as high as 750° F., holding a vacuum as low as 2 mm. Hg. abs.

Cost of the grease is not more than ordinary stopcock lubricants in use in most laboratories. The cracking catalyst costs approximately 16¢ a lb. in carload quantities. Laboratories should be able to purchase a pound or so for not more than 50¢ a lb. for experimental purposes. Screening to the 275- or 325-mesh from this quantity will yield two or three ounces, which, when mixed with a few ml. of glycerine (negligible cost) will produce enough lubricant for a great number of vacuum apparatus set-ups.

### Got an Answer for This One?

"What are some satisfactory methods for continuous feed of hygroscopic solids—such as aluminum chloride—on a small scale, for example in the pilot plant?" There's a chap in a refinery out in the mid-continent who would like an answer to that.

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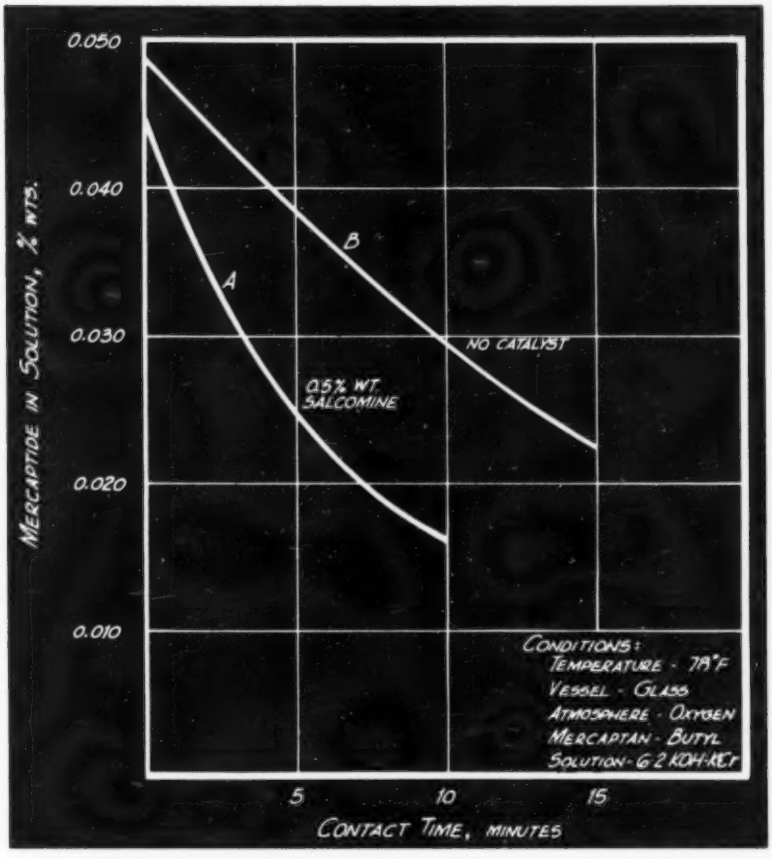
By Peter J. Gaylor, Patent Attorney, Newark, N. J.




**COMPARATIVE RATES OF OXIDATION** with catalyst and without

## Metallo-Organic Complexes Sweeten Mercaptan-Bearing Hydrocarbons

GASOLINE and other hydrocarbons containing sulfhydryls (mercaptans) can be sweetened by use of certain metallo-organic complexes known as chelates. According to U. S. Patent 2,651,595 issued to Socony-Vacuum Oil Co., Type I chelates are metallo-organic compounds consisting of one molecule of an aromatic aldehyde having a hydroxyl radical in the ortho position of the carbonyl group plus one molecule of a di- or tri-primary amine plus one atomic weight of a metal ion of Group VIII. Examples include combinations of salicylaldehyde with ethylene diamine and iron, 5-methyl salicylaldehyde with propylene diamine and cobalt, 3-carboxyl salicylaldehyde with phenylene diamine and nickel, etc.

Type II chelates are metallo-organic compounds consisting of one molecule of an aromatic compound having a hydroxyl group and a nitroso group substituted on adjacent carbon atoms of a benzene ring plus one atomic weight of a metal ion of Group VIII. Examples in this group include combinations of 3-methyl-6-nitrosophenol with cobalt, etc.

When the presence of the oxidation products of the mercaptans can be tolerated in the treated hydrocarbons, the process involves adding the chelate in an amount of one pound to five pounds per 1000 bbls. of hydrocarbon to be sweetened. Then the mixture is contacted with a solution of alkali metal hydroxide (5-40% NaOH) and then water washed. The caustic can contain solutizer.

Use of more than five pounds of chelate per 1000 bbls. is claimed to be accompanied by diminishing returns from an economic viewpoint.

The chelate can be used as a regeneration catalyst for fat alkali solutions of mercaptans. For example, an aqueous caustic (6N KOH-2N KAP) containing .045% by weight of butyl mercaptans was regenerated by adding 0.5% of cobalt disalicylal ethylene diamine and passing air through the solution. The graph at left shows the comparative rates of oxidation with catalyst (salcomine) and without.

The solution identified as 6N KOH-2N KAP is one containing 6 normal strength potassium hydroxide with sufficient potassium alkyl phenol salts to make the solution of two normal strength.

When 5 lbs. of Salcomine per 1000 bbls. is added to a sour gasoline containing .003 wt. % mercaptans and the mixture is extracted with KOH solution, the doctor test of the finished gasoline is on the borderline. A doctor sweet gasoline is obtained with 10 lbs. per 1000 bbls.

## Prepare Polymers From Hydrogenation of CO

PREPARATION of polymers which are essentially hydrocarbon in nature and are orientable by cold drawing, apparently quite similar to polyethylene, is described in U. S. Patent 2,652,372 issued to E. I. du Pont de Nemours & Co.

These hydrocarbon polymers have inherent viscosities of at least 0.74, and even above 2.0, with melting points above 140° C. They are made possible by the use of a catalyst containing molybdenum in chemical combination with oxygen and a metal whose ions are soluble in aqueous ammonia in excess of that stoichiometrically needed to precipitate the metal ion, in which combination the oxygen:molybdenum atomic ratio is 1.5:1 to 3:1.

An example given uses a silver lined vessel in which 97 parts of tetrahydronaphthalene solvent, 15 parts of nickel molybdite, 5 parts of a mixed dodecyl acid phosphate and a gas mixture composed of 2 moles of hydrogen per mole of carbon monoxide are heated at 175° C and 1000 atmospheres pressure for 14 hrs., the pressure being maintained by repressuring with the same gas mixture.

The polymer is precipitated from the solvent by addition of methanol.

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### *Patents Issued in September*

*The following classified listing gives the patent number, patentee, or assignee, and a brief description of all patents believed to be of interest to the petroleum processing industries, as contained in the Official Gazette of the U. S. Patent Office for September 1, 8, 15, 22 and 29, 1953, Vol. 674, Nos. 1-5.*

## PROCESSES

### Refining

2,650,670 (Gulf Research & Development Co.) Molecular filtration (diffusion).
2,650,897 (Sinclair Refining Co.) Solvent extraction of asphaltic residues with butane.
2,651,594 (Standard Oil Development Co.) Kerosene finishing process, using $SO_2$ extraction.
2,651,595 (Socony-Vacuum Oil Co.) Converting sulfhydryl to sulfide with oxygenated metal chelate.
2,651,596 (Standard Oil Co.-Ind.) Refining of mercaptan-containing virgin distillates with sulfuric acid and $SO_2Cl_2$.
2,651,602 (Lummus Co.) Process and apparatus for clay contacting in the refining of lubricating oil.
2,651,603 (Standard Oil Development Co.) Fractionation with solid adsorbents.
2,651,666 (Upton Oil Co. of California) Adsorption process.
2,652,130 (California Research Corp.) Gas-oil separator.
2,652,239 (Standard Oil Development Co.) Fractionation and distillation tray structure.
2,652,316 (Standard Oil Development Co.) Liquid-liquid contacting apparatus.
2,652,435-6 (The Texas Co.) Process for separating p-dycyclic aromatic compounds from organic mixtures, by reacting with tetrahalophthalic anhydride and decomposing fused polycyclic complex with steam.
2,652,437 (Phillips Petroleum Co.) Adsorption-stripping separation system to produce gas oil of enhanced aromaticity.
2,652,439 (Phillips Petroleum Co.) Hydrocarbon separation by solvent extraction.
2,653,122 (The Texas Co.) Fractional separation of oil with a complexing agent such as urea in the presence of a solvent liquid.
2,653,123 (The Texas Co.) Continuous process for separation of waxlike constituents from oil (using urea).
2,653,124 (Standard Oil Co.-Ind.) Process for sweetening hydrocarbon oils with oxygen and dry cupric chloride followed by addition of copper metal deactivator.
2,653,125 (Standard Oil Co.-Ind.) Process for sweetening hydrocarbon oils using copper sulfate and oil soluble copper sulfonate on adsorbent.
2,653,175 (Sun Oil Co.) Preparation of aromatic hydrocarbons by dehydrogenation and selective adsorption.

### Catalysts

2,650,906 (Shell Development Co.) Preparation of impregnated type tungsten and molybdneum catalysts.
2,651,599 (Standard Oil Development Co.) Treating cracking catalysts with HF for reactivation.
2,651,600 (Standard Oil Development Co.) Method of reducing contaminants on finely divided catalyst by control of particle size.
2,561,617 (Universal Oil Prods.) Treatment of alumina containing catalytic composites.
2,652,371 (Sinclair Refining Co.) Process of forming spheroidal catalyst particles from sodium silicate solution.

### Conversions

2,651,565 (Universal Oil Products Co.) Apparatus for uniform distribution and contacting of subdivided solid particles.
2,651,597 (Standard Oil Development Co.) Process for improving the octane number of virgin light naphthas by fractionating to hexane fraction which is isomerized, etc.
2,651,598 (Atlantic Refining Co.) Reforming process and platinum catalyst.
2,651,601 (Standard Oil Development Co.) Preparation of feed material for catalytic cracking by distilling crude, visbreaking residual, etc.
2,652,317 (Standard Oil Development Co.) Reactor inlet.
2,652,434 (Universal Oil Products Co.) Alkylation of aromatics.
2,653,176 (Sinclair Refining Co.) Production of aromatics from petroleum by hydrodealkylation.
2,653,859 (Hercules Powder Co.) Apparatus for pyrolyzing reactants.
2,653,903 (Phillips Petroleum Co.) Hydrocarbon conversion, using combustion.
2,653,981 (Phillips Petroleum Co.) Process for methyl group shifting of olefin, using catalyst.
2,653,982 (Sun Oil Co.) Catalytic alkylation of isoparaffins with olefins (with $BF_3$ and alkyl fluoride).

### Hydrocarbon Synthesis

2,650,481-2 (M. W. Kellogg Co.) Separation of air by liquefaction.
2,651,652 (The Texas Co.) Catalytic synthesis of hydrocarbons and oxygenated organic compounds.
2,651,653 (Standard Oil Development Co.) Two-stage hydrocarbon synthesis.
2,651,654 (Standard Oil Development Co.) Treatment of hydrocarbon synthesis naphtha.
2,651,655 (M. W. Kellogg Co.) Treatment of hydrocarbon waxes from synthesis reaction.
2,652,319 (Standard Oil Development Co.) Process for water gas generation.
2,652,319 (Standard Oil Development Co.) Proc- of organic oxygenated compounds.
2,653,959 (The Texas Co.) Process for recovering oxygenated organic compounds.
2,653,960 (The Texas Co.) Process for treating synthesis product.
2,653,961 (Phillips Petroleum Co.) Recovery of oxygen compounds from Fischer-Tropsch product.

## PRODUCTS

### Chemicals

2,650,660 (Phillips Petroleum Co.) Method of adjusting the concentration of ammonium nitrate solutions.
2,650,941 (Shell Development Co.) Conversion of carbohydrates to polyhydric alcohols.
2,650,942 (Hooker Electrochemical Co.) Production of hexachloro cyclopentadiene.
2,651,606 (Shell Development Co.) Resolution of mixtures comprising n-methylaniline and n,n-dimethylaniline.
2,651,620-3 (Ethyl Corp.) Stabilized elastomeric compositions.
2,651,626 (Shell Development Co.) Vinyl halide-vinylidene halide-arcylic ester tripolymers.
2,651,665 (Standard Oil Development Co.) Recovery of pure paraxylene.
2,652,342 (Standard Oil Development Co.) Synthetic drying oil and enamel paint and process of making same.
2,652,372 (E. I. du Pont de Nemours & Co.) Catalytic hydrogenation of carbon monoxide to orientable, essentially hydrocarbon polymers.
2,652,384 (Standard Oil Development Co.) Composition of a premilled butadiene-acrylonitrile copolymer and a non-rubbery thermoplastic synthetic resin.
2,652,404 (Socony-Vacuum Oil Co.) Preparation of 2-thenyl-formaldimines.
2,652,405 (The Texas Co.) Alkylation of thanaphthene.
2,652,410 (Union Oil Co. of Calif.) Esters of alphahydroxy acids and their estolides.
2,652,411 (United States of America) Alkyl acyloxy stearates.
2,652,413 (The Texas Co.) Process for preparing alkanoic acids.
2,652,426 (California Research Corp.) Preparation of alkane phosphonic acids.
2,652,429 (Socony-Vacuum Oil Co.) Reaction of cracked petroleum fractions, formaldehyde and ammonium halides and products.
2,652,430 (The Texas Co.) Process for separating acenaphthene with tetrahalophthalic anhydride.
2,653,077 (Phillips Petroleum Co.) Production and recovery of ammonium sulfate.
2,653,138 (Socony-Vacuum Oil Co.) Tellurium catalysts.
2,653,158 (Standard Oil Development Co.) Preparation of acyl-p-amino-phenols.
2,653,161 (Shell Development Co.) Sulfur and phosphorus-containing esters.

2,653,165 (California Research Corp.) Oxidation of toluic acid esters to produce esters of phthalic acids.
2,653,172 (Shell Development Co.) Stabilization of acrolein with copper and hydroquinone.
2,653,391 (Phillips Petroleum Co.) Method for drying ammonium nitrate and like materials.
2,653,471 (Socony-Vacuum Oil Co.) Thermo-acoustic gas analyzer.
2,653,913 (Shell Development Co.) Synthetic detergent cakes.
2,653,952 (Chempatents, Inc.) Process for the manufacture of ethylene oxide by oxidation of ethylene.
2,653,956 (Phillips Petroleum Co.) Drying oil compositions.
2,653,962 (Celanese Corp. of America) Oxidation control.
2,653,963 (American Cyanamide Co.) Catalytic addition of cyanogen halides to olefins.
2,653,980 (Phillips Petroleum Co.) Alkylation of aromatic hydrocarbons with isoparaffins.

## Fuels

2,651,173 (Standard Oil Development Co.) Process and apparatus for operating engines at high altitudes, using injection of hydrocarbon and oxygen.
2,653,159 (Ethyl Corp.) Manufacture of tetraethyllead.
2,653,160 (United States of America) Preparation of organo-metallic compounds by reaction between dry diazonium compounds and metallic salts in organic solvents.
2,653,620 (Phillips Petroleum Co.) Process and means for regulating the gas pressure in containers.
2,653,862 (Phillips Petroleum Co.) Monoisopropyl amine as an octane improver of leaded gasoline.

## Lubricants

2,651,616 (Shell Development Co.) Lithium hydroxy stearate grease compositions.
2,651,628 (Standard Oil Development Co.) Process for alkylating polystyrene for lubricant additive.
2,651,657 (Standard Oil Development Co.) Synthetic ester lubricating oil.
2,652,361 & 3 (Shell Development Co.) Gasoline-resistant grease compositions containing inorganic colloidal gel.
2,652,362 (Shell Development Co.) Grease composition containing P-S reaction product and aromatic amine.
2,652,364 (Shell Development Co.) High-temperature grease compositions based on Polyhydrocarbylsiloxane.
2,652,365 (Shell Development Co.) Wide temperature grease compositions using light and heavy oils.
2,652,366 (Shell Development Co.) Method of preparing lubricating grease compositions using controlled quenching.
2,652,367 (Shell Development Co.) Lubricating composition stabilized with organic carbonyl compound-polyamine product.
2,652,368 (Shell Development Co.) Lubricating oil composition having cracked wax olefin—$SO_2$ copolymer VI improver.
2,652,370 (Sinclair Oil and Gas Co.) Process for breaking soap-thickened petroleum gels with sulfonated bottoms.
2,652,412 (Benjamin Clayton) Fractionation of black grease to recover fatty acids and neutral oil.
2,653,131 (Standard Oil Development Co.) Aluminum-carbon black thickened grease compositions.
2,653,132 (Standard Oil Development Co.) Oxo-bottoms base lubricating grease.
2,653,133 (E. I. du Pont de Nemours & Co.) Nitrile copolymers and lubricants containing the same.
2,653,517 (Gulf Research & Development Co.) Jet method of applying cutting liquids.
2,653,909 (Standard Oil Co.-Ohio) Soluble oils comprising neutralized oxidized petroleum oils.
2,653,910 (Shell Development Co.) Extreme pressure lubricants containing organic trichalcogenone.
2,653,911 (Monsanto Chemical Co.) Hydrocarbon oil compositions containing telomeric polyalkyl oxoesters as anti-foaming agents.

## Specialties

2,652,341 (Lubrizol Corp.) Asphalt-clay emulsion containing alkali metal paraffin wax hydroxy phenyl sulfonate.
2,652,344 (Phillips Petroleum Co.) Carbon black pelleting.
2,653,135-7 (Cities Service Research & Development Co.) Surface active compounds for resolving emulsions.
2,653,177 (California Research Corp.) Inhibition of phosphoric acid corrosion with copper in solution.


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## Miscellaneous

2,650,480 (Phillips Petroleum Co.) Low-temperature absorption refrigeration.
2,650,496 (Phillips Petroleum Co.) Fluid flowmeter with heated resistance bridge circuit.
2,650,499 (Sun Oil Co.) Sampling adapter for receptacles.
2,650,556 (Shell Development Co.) Applicator for distributing mixtures of vapors and liquid for agricultural use.
2,651,320 (Atlantic Refining Co.) Gate valve.
2,651,922 (Phillips Petroleum Co.) Crystallization process and apparatus.
2,651,938 (Standard Oil Development Co.) Tank gauging apparatus.
2,651,995 (Phillips Petroleum Co.) Switch for automatic pumping units.
2,652,129 (Hydrocarbon Research, Inc.) Separation of mixed gases by absorption.
2,652,141 (Phillips Petroleum Co.) Continuous weighing mechanism for solids.

# EQUIPMENT

## Processing, general

2,650,555 (Vape-O-Plate Co.) Baffle member for combustion chambers.
2,650,809 (C. F. Braun & Co.) Bubble cap and riser assembly.
2,651,414 (Lanson Products Corp.) Hydrocarbon separator apparatus and separator element.
2,651,415 (Bethlehem Steel Corp.) Oil separator.
2,651,512 (Georges Claude) Gas and liquid contact apparatus.
2,652,129 (Hydrocarbon Research, Inc.) Separation of mixed gases by absorption.
2,652,130 (California Research Corp.) Gas-oil separator.
2,652,238 (Humes B. Manley) Bubble tray water decanter.
2,652,239 (Standard Oil Development Co.) Fractionation and distillation tray structure.
2,652,317 (Standard Oil Development Co.) Reactor inlet.
2,652,316 (Standard Oil Development Co.) Liquid-liquid contacting apparatus.
2,653,018 (Gilbert & Barker Mfg. Co.) Fastening device for bubble cap assemblies.
2,653,675 (George E. Lynch) Gas cleaning apparatus.
2,653,859 (Hercules Powder Co.) Apparatus for pyrolyzing reactants.

## Instruments

2,650,496 (Phillips Petroleum Co.) Fluid flowmeter with heated resistance bridge circuit.
2,650,561 (Bendix Aviation Corp.) Fluid flow indicator.
2,650,562 (U.S.A.) Method and device for visual observation of dense-phase suspensions.
2,650,605 (Electro-Hydraulics Ltd.) Pressure regulating device.
2,651,200 (Pearl E. Colburn) Tank gage.
2,651,201 (Tesa, S. A.) Measuring instrument for determining humidity of gaseous mixtures.
2,651,204 (International Business Machines Corp.) Automatic pressure measuring and indicating system.
2,651,323 (Ateliers Neyret-Beylier and Piccard-Pictet) Pressure regulator.
2,651,327 (General Electric Co.) Liquid filled expansible chamber.
2,651,328 (Charles B. Gamble) Pressure responsive apparatus and diaphragm.
2,651,938 (Standard Oil Development Co.) Tank gaging apparatus.
2,651,939 (Comstock & Westcott, Inc.) Apparatus for measuring contents of large tanks.
2,651,940 (U.S.A.) Apparatus for measuring liquid level.
2,651,942 (Foxboro Co.) Linear responsive vapor pressure thermometer.
2,651,995 (Phillips Petroleum Co.) Switch for automatic pumping units.
2,651,996 (Donald R. Nahmens) Pump motor controller.
2,652,495 (Harold W. Washburn) Process monitor mass spectrometer.
2,652,721 (Phillips Petroleum Co.) Thermal flowmeter.
2,652,725 (Weston Electrical Instrument Corp.) Bimetallic thermometer mounting for double-walled tanks.
2,652,727 (Hays Corp.) Device for measuring absolute pressure.
2,652,846 (Phillips Petroleum Co.) Flow control apparatus.
2,653,178 (Speed Development Co. Ltd.) Thermocouple device.
2,653,471 (Socony-Vacuum Oil Co.) Thermoacoustic gas analyzer.
2,653,477 (Elvin E. Hoskins) Liquid level gage.
2,653,478 (Robert W. Harper) Gage for liquid containers.
2,653,479 (Buffalo-Eclipse Corp.) Liquid level gage.
2,653,623 (Ralph Hippen and Clayton Murphy) Liquid level control.
2,653,753 (Paul H. Davey) Compressor regulator.
2,653,793 (Weatherhead Co.) Pressure regulator.

## Pumps & Compressors

2,650,543 (Societe d'Installation et d'Appareillage) High pressure radial piston pump.
2,650,544 (John B. Parsons) Rotary pump assembly.
2,650,545 (Richard T. Cornelius) Diaphragm pump.
2,650,573 (Albert F. Hickman) Rotary fluid motor or pump.
2,651,264 (De Florez Co.) Fluid pump.
2,651,533 (D. Napier & Son, Ltd.) Rotary pump.
2,651,994 (Houdaille-Hershey Corp.) Variable capacity pump with dual discharge means.
2,651,997 (John J. Lyth) Diaphragm pump.
2,651,998 (Dayton Pump & Mfg. Co.) Centrifugal pump.
2,651,999 (Lester B. Harrington) Rotary pump.
2,653,546 (Alfred S. Marlow, Jr.) Self-priming pump.
2,653,552 (Geeraert Corp.) High pressure pump.

## Valves & Fittings

2,650,456 (C. A. Nogren Co.) Pressure regulating valve.
2,650,792 (John Marco) Mixing valve.
2,650,793 (Loyola University Foundation) Check valve.
2,650,863 (John D. Fore) Automatic cut-off valve.
2,651,320 (Atlantic Refining Co.) Gate valve.
2,651,324 (New York Air Brake Co.) Multiple control valve.
2,651,325 (Ohio Brass Co.) Valve control mechanism.
2,651,326 (General Control Co.) Diaphragm valve having an adjustably mounted pivoted pilot valve.
2,651,490 (American Car & Foundry Co.) Balanced plug valve.
2,651,491 (Electrol, Inc.) Shuttle valve.
2,652,033 (Shafer Valve Co.) Pressure fluid actuated valve operating mechanism.
2,652,851 (Crane Co.) Pilot valve and indicator construction.
2,652,852 (Aktiebolaget Max Sievert) Float controlled tank filling valve.
2,652,946 (Guy M. Beatty) Cleanout gate valve.
2,653,003 (John M. Overbeke) Control valve.
2,653,004 (Gesellschaft der Ludw. von Roll'schen Eisenwerke A. G.) Pivoted stop valve.
2,653,005 (Richard T. Cornelius) Valve.
2,653,788 (Crane Co.) Connection for diaphragm valves.
2,653,789 (McEvoy Co.) Gate valve.
2,653,791 (Mueller Co.) Plug stop valve.
2,653,792 (Marquette Metal Products Co.) Check valve.

## Gaskets & Seals

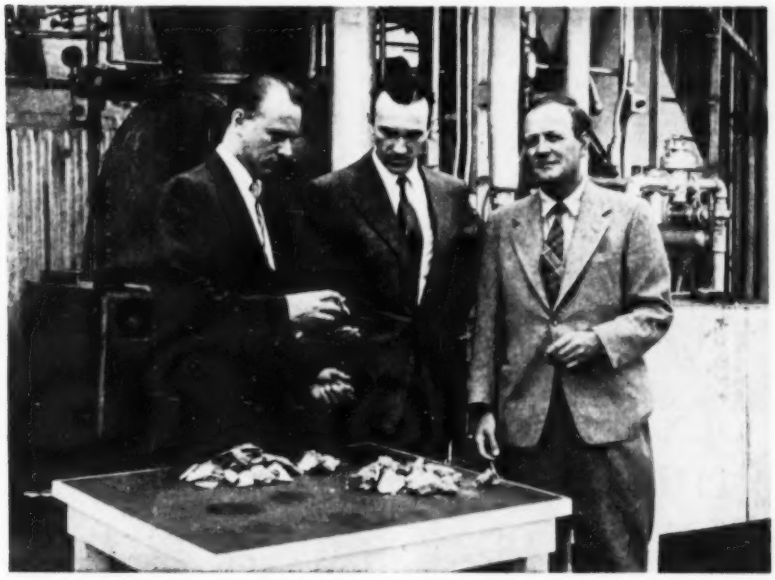
2,650,841 (Rotary Seal Co.) Shaft seal.
2,650,842 (Cassman Mfg. Co.) Shaft sealing device.
2,651,434 (Keith M. Adair) Liquid seal trap.
2,651,534 (Victor Mfg. & Gasket Co.) Sealing device.
2,652,223 (Melville F. Peters) Sealing of fluid systems.
2,653,833 (Crofoot Gear Corp.) Rotary pressure fluid seal.
2,653,837 (Crane Packing Co.) High pressure rotary seal.

## Tanks & Vessels

2,651,192 (William Allen Sons Co.) Closure for processing tanks.
2,651,415 (American Pipe & Steel Corp.) Tank with floating roof.
2,651,921 (John W. Du Rant) Storage and vaporizing apparatus for liquified petroleum gas mixtures.

### How to Obtain Patents

*Readers may obtain copies of any U. S. Patent from the Patent Office at 25¢ each. Order by patent number direct from the Commissioner of Patents, Washington 25, D. C.*



## Test Brazilian Oil Shale in California

The first commercial-scale oil shale plant in the western hemisphere may be the result of tests recently run at Union Oil Co. of Calif.'s retort pilot plant at Wilmington.

Samples of Brazilian oil shale were analyzed to determine whether building of an 8,000 b/d plant near Sao Paulo, Brazil, would be feasible. On hand for the test were, left to right, Dr. Clyde Berg, manager of process development, Union Oil, and frequent contributor to the pages of PETROLEUM PROCESSING, Dr. Jose Schor, U. S. representative, National Council of Brazil, and Phillip Verity, chemical engineer, Foster Wheeler Corp.

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**C. P. Brewer** has been appointed special assistant to the president of Shell Development Co.

In his new position, Mr. Brewer will serve as a liaison with the Emeryville, Calif. oil and chemical research division. He was formerly supervisor of petroleum research at that location.

Mr. Brewer received his PhD in organic chemistry from McGill University in Montreal, and first joined Shell at Emeryville in 1946.

**Dr. Wilburn C. Schroeder** has resigned as assistant director for programming for the Bureau of Mines, to teach chemistry and chemical engineering at the University of Maryland.

Receiving his doctor's degree from the University of Michigan in 1933, Dr. Schroeder joined the Bureau that same year as a chemical engineer.

After directing research on high-temperature corrosion, carried out in cooperation with the American Society of Chemical Engineers, he became assistant chief of the Fuels and Explosives Division in 1939. In 1945 he was appointed chief of the Synthetic Liquid Fuels Branch of that division, established to administer the Synthetic Liquid Fuels Act, remaining in that position until his appointment as an assistant director of the Bureau in 1951.

Dr. Schroeder is a member of the American Chemical Society, the American Petroleum Institute and a number of other professional societies.

**Dr. Arthur P. Lien** has won one of the top ten awards of the American Chemical Society for his basic research in petroleum chemistry.

Dr. Lien will receive the award, which includes $1,000, at the 125th meeting of the society in Kansas City, Mo., early in 1954. He is an associate division director in the Whiting research laboratories of Standard Oil Co. (Ind.), and is best known for his work on aromatic hydrocarbons. He has extended the number of "arenes" which can be derived from petroleum, and has also done important work on the separation of sulfur compounds from oil products, and preparation of high-octane gasoline components by the isomerization process.

A graduate of Ottawa University in Kansas, Dr. Lien took his doctor's degree in chemistry at Ohio State University. He joined Standard in 1941, and was promoted to his present position earlier this year.

**Dr. Everett C. Hughes,** chief of the chemical physical research division of Standard Oil Co. (Ohio), has been named chairman of the management committee for the Gordon Research Conferences this coming year.

Each conference is on a special subject of chemical or biological interest, and the first one each year is on the chemistry of petroleum. About 30 conferences will be held next year.

**Robert Siegel** has been elected a director and executive in charge of Middle East affairs for Socony-Vacuum Oil Co., Inc. He fills a vacancy on the board left by the recent death of **Charles L. Harding.**

**Aubrey D. Hill** has been appointed assistant manager of manufacturing, lubricating oils and waxes, and **W. Vaughn Ischie** has been named assistant manager of light oil operations, Sinclair Refining Co.

Mr. Hill

Mr. Ischie

Mr. Hill, a chemical engineering graduate of the University of Illinois in 1924, joined Sinclair in the development department of the East Chicago refinery in 1923. After holding several supervisory posts, he was transferred to the New York office in 1944 in the division of manufacture of lubricating oils and waxes.

Mr. Ischie, who did his post-graduate work at the University of Chicago, joined Sinclair at East Chicago in 1920. Later he was named operating superintendent of that same refinery,

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a post he held until February, 1952, when he was granted a year's leave of absence to become director of the Foreign Refining Division, Petroleum Administration for Defense.

Sinclair has also announced establishment of a new marketing division for the sale of petroleum products used in the manufacture of other materials. Designated the process material division, the new organization will handle waxes, resins, petrolatums, industrial asphalts and other products. It will be under the direction of **Harold E. Bryson,** formerly manager of the firm's wax and petrolatum division. Functions of this latter division will be absorbed by the new section.

**Thomas B. Kimball** is the new general manager of refineries for Sinclair Refining Co., succeeding **John W. Duckett** who retired after 35 years service with Sinclair.

**Mr. Kimball**

Mr. Kimball joined the company in 1930 at the research and development department at East Chicago, Ind. Before being transferred to New York in 1943, he was in charge of the cracking division and engineering and development of light oil processes at the East Chicago refinery. In 1950 he was appointed assistant manager of refineries, the position he held prior to his present appointment. During the past several years he has developed numerous patents on light oil treating and on thermal and catalytic cracking.

Mr. Kimball received his degree in chemical engineering from the University of California in 1923, and has been identified with the petroleum industry ever since. He is a member of the American Petroleum Institute and the American Institute of Chemical Engineers.

**A. W. Scott,** president of Wolf's Head Oil Refining Co., was re-elected president of the National Petroleum Association at the group's 51st annual meeting at Atlantic City's Hotel Traymore in September.

**Philip M. Dean** has been named assistant director of the Foreign Refining Division, Petroleum Administration for Defense. He has been with PAD since September, 1952 as a spe-

cial assistant in that same division. Mr. Dean is on leave from the Standard Oil Co. (N. J.).

**Dr. F. D. Rossini** has been named chairman of the Petroleum Division of the American Chemical Society for 1954, and **Dr. E. C. Hughes** is chairman-elect.

Dr. Rossini

Dr. Hughes

Dr. Rossini is head of the chemistry department and director of the American Petroleum Institute research laboratory at Carnegie Institute of Technology. Dr. Hughes is head of the physical and chemical research division of Standard Oil Co. (Ohio).

Area representatives for the coming year are: Area I—**J. S. Ball,** Laramie, Wyo.; Area II—**Dr. R. W. Richardson,** Baton Rouge, La.; Area III—**Dr. V. Haensel,** Riverside, Ill.; Area IV—**Dr. W. J. Coppoc,** New York City; Area V—**A. C. Patterson,** Linden, N. J.; Area VI—**Dr. J. McAfee,** Pittsburgh, Pa.

The new position of managing editor of preprints and directory was created by the division, with the post going to **A. G. Oblad,** secretary-treasurer of the section for the past few years.

**John C. Lane,** former head of technical information services at the Georgia Tech Engineering Experiment Station, has joined the staff of the information services group of Ethyl Corp.'s research and engineering department at Detroit.

Mr. Lane

In his new post, Mr. Lane will assist in the preparation of technical publications pertaining to Ethyl's research in the automotive-petroleum field.

A well-known technical writer in the field of petroleum technology, Mr. Lane has headed documentation groups at the Gulf Research and Development Co. and the Institute of Gas Technology.

At present he is assistant editor of "Chemical Literature." He is a co-author of the book "Synthetic Petroleum from the Synthine Process."

**Ray J. Hull,** senior engineer with California Research Corp., received the first annual California Natural Gasoline Association award at the association's fall meeting in Los Angeles in October.

The award was created to stimulate activities within the association by younger men. Eligible are those under 43 whose services to CNGA in either technical or administrative activities has been outstanding.

**John W. Peirce** has resigned as vice president and general manager of the Western Oil and Gas Association to accept appointment as California State Director of Finance.

**L. L. Henning** has been appointed manager of Standard Oil of Calif. Co.'s Bakersfield refinery, succeeding **M. M. Moore** who has retired.

Mr. Henning

Mr. Henning, who joined Standard in 1934, was superintendent of the Richmond refinery chemical division when named to the new post. He started out in general engineering and has spent 12 years in the cracking division at Richmond.

A native of Red Bluff, Calif., Mr. Henning graduated from Stanford and took graduate work in chemical engineering at MIT.

Mr. Moore, head of the Bakersfield plant for the past 10 years, joined Standard in 1913, starting as a chemist in the El Segundo refinery. Later he served in managerial posts at both El Segundo and Richmond.

**Henry C. Meiners,** manager of Union Oil Co. of Calif.'s Oleum refinery, has been appointed manager of the firm's Wilmington refinery. He succeeds **Elmer B. Palmer,** who has been transferred to the company's general offices.

**John W. Towler,** chief refinery engineer at Wilmington, replaces Mr. Meiners at Oleum.


what's NEW in Engineering

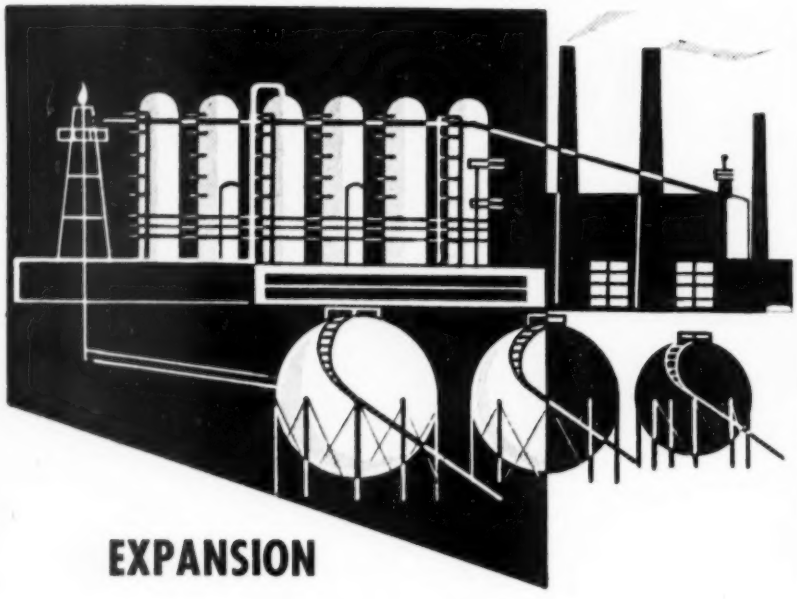
**A synthetic soil conditioner** has been announced which helps to control rain and wind erosion on construction sites, levees, rights of way and similar "bare ground" sites. Designed to stabilize aggregates on the soil surface, it helps to hold seeds and soil in place until vegetation cover takes over the job.

**Deep-sea divers** joined a small army of engineers and construction crews in driving over 42,000 piles at a riverside site for a Louisiana plant to provide a stable foundation in mushy ground. Divers, working 40 feet down in the Mississippi River, were required to direct

placement of the concrete seal. We'll send you a 32-page illustrated book which tells how Kaiser Engineers is equipped to meet challenging problems—like this one at the nation's largest aluminum plant, which was producing metal in just 10 months.

**A pocket pyrometer,** now on the market, gives direct reading of temperatures up to 3,300 deg. F. Only six and one-half inches long, it weighs about five ounces, and is shaped like a miniature telescope.

**Whether it's designing** an oil refinery, building a porcelain enameling plant or laying out a site plan, Kaiser Engineers undertakes the job with assurance because of the variety of talent within the organization. Successful experience in a wide field of design, engineering and construction tells the story. Call or write: Kaiser Engineers Division of Henry J. Kaiser Company, Kaiser Building, Oakland 12, California.



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## *Personals*

**C. O. McKinney** has been promoted to group leader in the technical service division at Standard Oil Co.'s (Ind.) research laboratories at Whiting, Ind.

Mr. McKinney joined Standard in 1946 as a chemical engineer in the research department at the firm's Sugar Creek, Mo., refinery. He is a graduate of the University of Illinois.

Mr. Brown

**G. Stewart Brown** has been elected national chairman of the American Petroleum Institute's Oil Industry Information Committee for 1954.

Mr. Brown, who is public relations manager of Standard Oil Co. of Calif., replaces **Stanton K. Smith,** president of Smith Oil & Refining Co.

At a recent meeting of the national committee, the following vice chairmen were also named: **Richard Rollins, W. R. Huber, Douglas Campbell, A. D. Eubank, and John S. Cooke.**

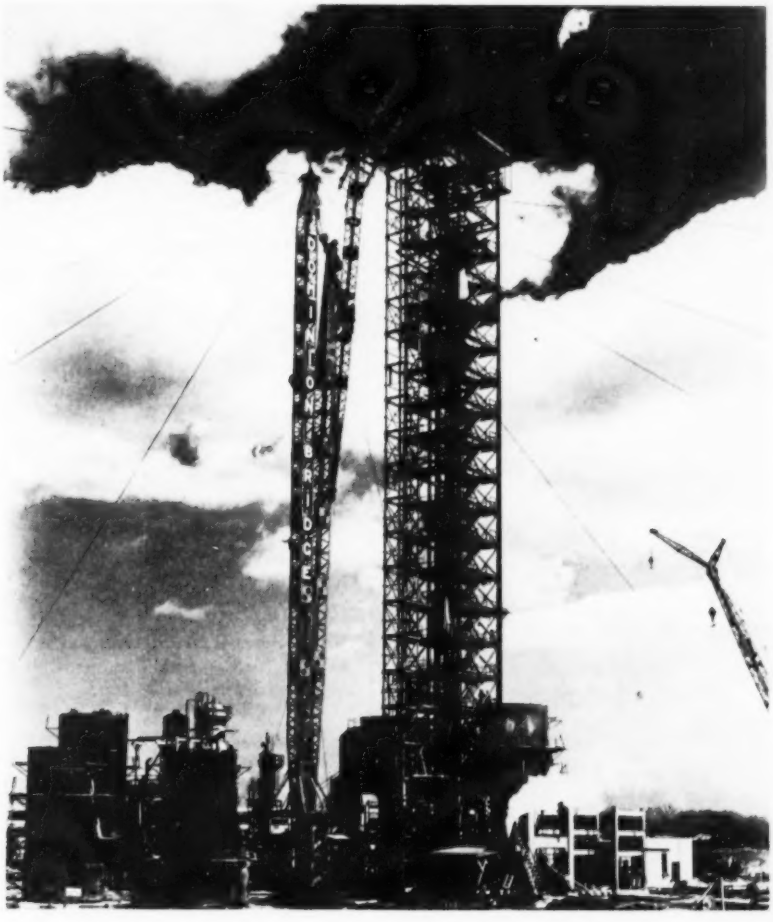
**M. M. Holm** has been appointed manager of process research and development at the Richmond laboratories of California Research Corp.

Other new Cal Research appointments are: **E. B. Chiswell,** chief process engineer; **L. F. Schimansky,** superintendent of refinery technical service; **J. Y. Beach,** supervisor of analytical and physical measurements division; **H. M. Lavender,** supervisor of process and plant design division; and **D. H. Etzler,** assistant to the general manager.

**Dr. Raymond W. McNamee** has been named manager of research administration of Union Carbide & Carbon Corp. Dr. McNamee will help coordinate research activities of all the company's labs where basic research is being performed on alloys, chemicals, gases, carbons and plastics.

Dr. McNamee previously was superintendent of the research and development department of Carbide and Carbon Chemicals Co., a division of Union Carbide. His successor in that post is **Dr. Franklin Johnston,** formerly assistant director of research for the company.

**Dr. Henry C. Chitwood**, former research group leader, has been advanced to assistant director of research, organic chemicals.



## Canada's Biggest Derrick Busy at Refinery

This 150 ton erection derrick, biggest of its kind to be built in Canada, is now being used to help build a refinery for Sun Oil Co. at Sarnia, Ontario. Contractors for the job are Catalytic Construction Co. of Canada.

Five railroad cars were needed to carry the derrick from the Dominion Bridge Co. works at Lachine, where it was built. The derrick is equipped with a 160 ft. boom and 180 ft. mast, mounted on a spherical roller thrust bearing.

The derrick has been designed so that boom and mast be used independently as poles for supporting heavy vessels. At the Sarnia job, the derrick was mounted on a 15 ft. self-supporting tower, giving a 200 ft. total height.

### *U. S. Rubber Names New VP*

John E. Caskey has been elected a vice president of United States Rubber Co., and general manager of the company's Naugatuck Chemical Division. He succeeds vice president John P. Coe, who will handle the company's interests in the transfer of synthetic rubber plants from the government to private industry.

At the same time, George R. Vila, formerly general sales manager of Naugatuck, will become assistant general manager of the division.

All sales, research and production activities of Naugatuck will be directed by Mr. Caskey and Mr. Vila.

### *New Welding Electrode Plant*

A. O. Smith Corp. recently completed a new welding electrode plant at Lancaster, Pa., at a cost of about $1 million. In its new facilities, Smith plans to mass manufacture electrodes while maintaining hygienic "laboratory" conditions. Extensive care has been taken in planning and construction to eliminate dirt and dust sources from the plant.

### *Klinger Forms American Co.*

Richard Klinger, Ltd., English manufacturers of gages, gaskets, and valves, has formed the Klinger Corp. of America, an American subsidiary, with headquarters in Hoboken, N. J.

L. O. Arringdale is president of the new company, and Vincent Maxwell and Raymond Oksala are senior engineers.

### *Meter Co. Puts Up Building*

Canadian Meter Co., Ltd., subsidiary of American Meter Co., has completed construction on a new fabrication, repair and warehouse building in Edmonton, Alta.

The building was put up to answer demands for meters and controls by the growing oil and gas industry in that area.

### *Foster Grant Appoints Three*

Foster Grant Co. has acquired the services of three plastics engineers, in a bid by the company to increase its participation in the plastics raw materials field.

Mr. LaBelle

John W. LaBelle has been named director of sale of the newly-formed Petrochemical Division.

Mr. Kovach

Mr. Bishop

He is a graduate of Northeastern University, and prior to his present appointment was New England district sales manager of Koppers Co.'s Chemical Division.

Richard B. Bishop, formerly a re-

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search specialist for the Socony-Vacuum Oil Co., has been named director of research in the Petrochemical Division. Mr. Bishop is a graduate of Holy Cross College and performed post-graduate work at Johns Hopkins University and Rutgers University.

George Kovach will be product development manager in the new set-up. He was educated in Vienna, Austria, and until recently was manager of the plastics division of Clopay Corp.

### Personnel Changes

**Lubrizol Corp.**—John H. Baird to assistant to the vice president in charge of marketing and sales in the Cleveland office; William W. Schafer to mid-continent sales representative at Tulsa; and Charles B. Collins to sales representative for the east central areas of the U. S. and Canada.

**Celanese Corp. of America**—Raymond A. Gobeil to head of the physical testing laboratory at the Summit Research Laboratories, and Harold K. Haviland to associate head of the technical information section.

**Pullman, Inc.**—Dr. W. E. Hanford, vice president in charge of research and development, M. W. Kellogg Co., a Pullman subsidiary, to the board of directors of the parent company.

**Rockwell Mfg. Co.**—A. A. Fomilyant to general manager of the company's Macnick Division at Tulsa, Okla., from Los Angeles district manager of the Meter and Valve Division.

**Wright Chemical Corp.**—Dr. Paul G. Bird to director of research and development.

**Flexonics Corp.**—Thomas K. Wells to general sales manager from sales manager for the Bellows and Aircraft Divisions.

**Westinghouse Electric Corp.** — David W. R. Morgan to headquarters staff of John K. Hodnette, vice president in charge of the company's industrial products division.

**Edward Valves, Inc.**—H. W. Bierman to sales engineer in parent company Rockwell Mfg. Co.'s Tulsa, Okla. offices.

**Calumet & Hecla, Inc.**—Ralph Julin to the Wolverine Tube Division's midwestern sales office in Chicago, and Thomas E. Goodyear to the Des

Moines, Iowa, sales office of that same division.

**Robertshaw-Fulton Controls Co.**—R. M. Stotsenburg to sales manager of Fielden Instrument Division, from the sales department of the R.C.A. Victor Division.

**Affiliated Gas Equipment, Inc.**—Joseph A. Cerny to manager of the sales engineering and information section at the Bryant Heater division, and Paul J. Schaack to Cleveland branch sales manager.

**Ansul Chemical Co.**—C. Victor Mars to vice president in charge of research and development from director of the same department.

**Worthington Corp.**—L. J. McKenna to district office manager at the company's Tulsa, Okla., office from the New York district sales office.

**Babcock & Wilcox Co.**—W. D. Sullivan to regional manager of the Boiler Division from assistant works manager of the Tubular Products Division at Beaver Falls, Pa.

**Trane Co.**—Raymond O. Goodman to the Chattanooga, Tenn., sales office, Robert E. Murphy to the Milwaukee, Wisc. sales office, and Richard E. Haskins to the Oklahoma City, Okla. sales office.

**Simpson Electric Co.—Merton W.** Whitney to sales staff from sales engineer with Cook Electric Co.

**Cunneen Co.**—James P. Raugh to the executive staff from vice president of General Refractories Co.

**Peabody Engineering Corp.**—William F. Lange to the newly-established post of assistant chief engineer from design engineer.

**Cooper-Bessemer Corp.** — R. L. Moore to sales engineer at the company's Chicago office.

**Food Machinery & Chemical Corp.**—Everett W. Lundy to assistant sales manager, Peerless Pump Division, from Pacific district manager.

**De Laval Steam Turbine Co.**—Arthur L. Foltz, Jr. to manager of the Detroit district office.

**Arthur G. McKee & Co.**—H. R. Moorhouse to treasurer in addition to


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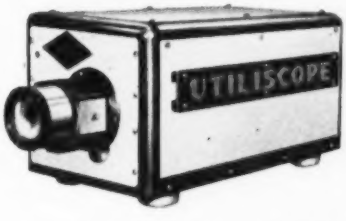


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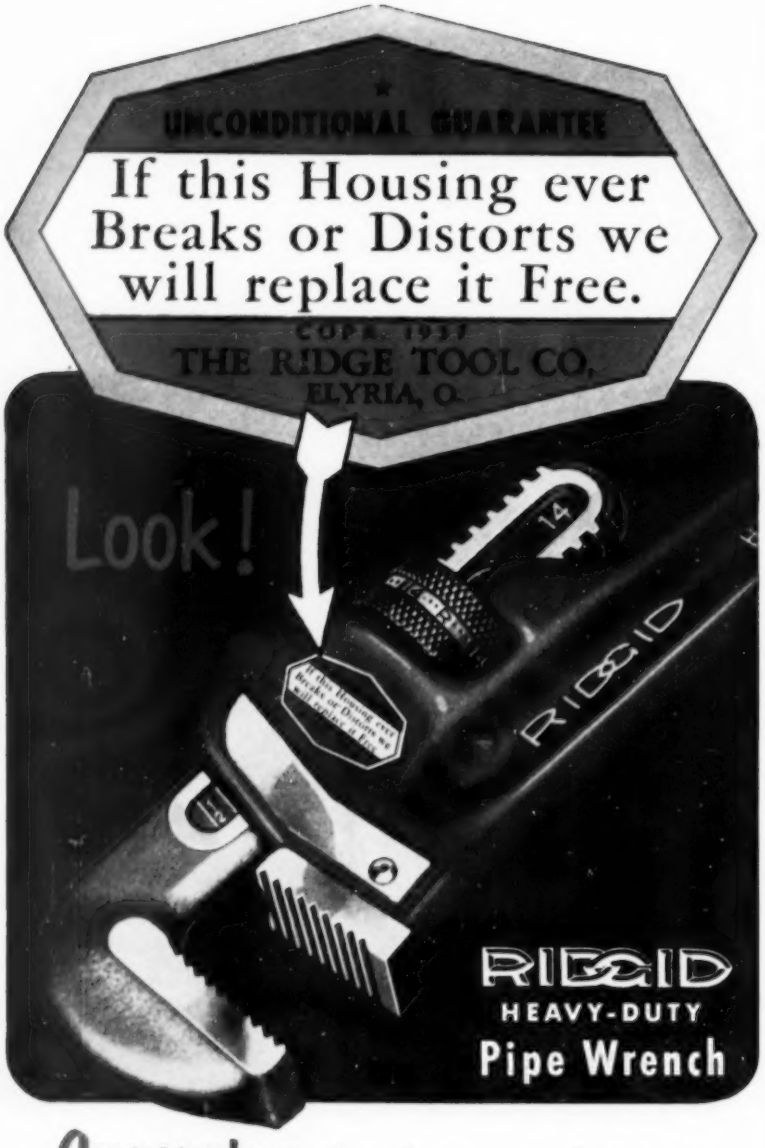


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his present duties as secretary, succeeding J. Krumhansel who retires January 2, 1954.

### *Branches, Distributors*

**Minneapolis - Honeywell Regulator Co.** has opened a new sales office and warehouse in Dallas, Texas, which will house the company's Southwestern regional office.

**Patterson Foundry & Machine Co.** has a new district sales office in Tulsa, Okla., with W. V. C. Jackson in charge.

**Vernon Tool Co.** and D. H. Greenwood, valve engineer, have completed a contract whereby Vernon Tool becomes the exclusive licensee for the manufacture and sale of Greenwood valves.

**Arthur D. Little, Inc.** has formed a new midwest liaison office in Chicago. John R. Kirkpatrick heads the operation.

### *Expansion, Transition*

**Telecomputing Corp.** says it plans to start construction on a $400,000 expansion project to increase production up to four times present output. Company hopes construction will eventually allow giving up present leased quarters.

**E. F. Houghton & Co.'s** board of directors has approved plans for an expanded research program, including a further addition to the laboratories. Construction is to begin sometime this fall.

**R-S Products Corp.'s** Furnace Division has incorporated, and will be known as the R-S Furnace Corp., a subsidiary of Hardinge Co. Address and personnel of the division remain unchanged.

**Flexonics Corp.** is transferring brass bellows construction to its recently completed Memphis plant addition from the pilot plant at Elgin, Ill. Company output of brass bellows is expected to be six times that of present production.

**Lunkenheimer Co.** is expanding its facilities for manufacture of iron and steel valves at the Carthage, Ohio plant.

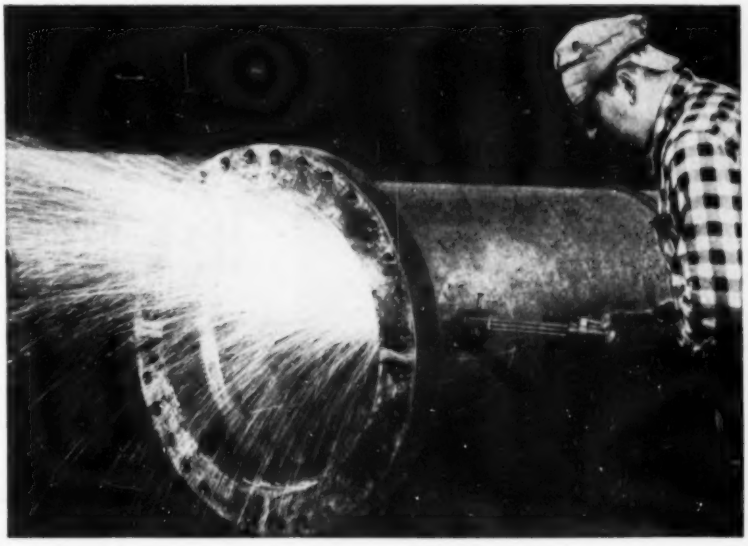
# PROCESS EQUIPMENT NEWS

PUBLISHED BY FABRICATED PRODUCTS DIVISION, THE M. W. KELLOGG COMPANY NOVEMBER 1953

## Shop Stream-lined to Raise Capacity

Stream-lining of Kellogg's heat exchanger fabrication facilities is continuing as new equipment is installed in a program aimed at providing production-line manufacture of tubular heat transfer equipment.

As a result of this program, which also includes the rearrangement of existing equipment and layout, Kellogg has been able to accelerate the production of the wide variety of units regularly coming into the shop. For example, a recent order for 200 stainless steel heat exchangers with shells 48 inches inside diameter and tube bundles having 20 foot tubes, was completed in less than 18 months after the order was received.



## Cutting Accurate Bevel in Nozzle Hole Essential to Efficient Welding

While there is no unusual skill required in shaping a nozzle hole in an exchanger shell when its outline and location have been clearly indicated by a qualified layout man, it is quite a trick to cut these holes with the proper bevel to produce a perfectly welded joint when the nozzle is attached.

Here, one of Kellogg's highly skilled craftsmen is cutting the inlet nozzle hole in a crude preheater scheduled for installation in a large Gulf Coast refinery. When installed it will exchange heat from a naphtha cut with crude entering a topping still.

The shell, 7/8 inch thick, has an inside diameter of 27 inches. It will contain a tube bundle having 255 one-inch steel tubes on a 1¼" square pitch.

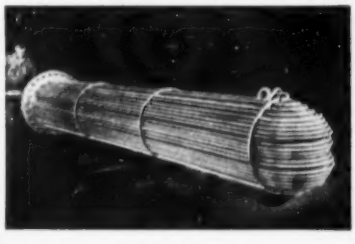
## Large Tube Sheet for Chemical Plant Heat Exchanger

When drilling and machining is completed, this large aluminum-killed forged-steel tube sheet will become part of a heat exchanger destined for service in a chemical plant operated by a major U. S. processor.

The unit, 60 inches inside diameter and 18 feet long, and containing 5900 sq. ft. of effective tube surface is designed to operate at 8°F on the shell side and 17°F on the tube side.

## Chrome-Moly U-Tube Bundle for Reboiler

For further information, details of methods, etc. contact
FABRICATED PRODUCTS DIVISION
THE
M. W. KELLOGG
COMPANY
225 Broadway, New York 7, N. Y.
or offices in Jersey City, Buffalo, Los Angeles, Tulsa, Houston, Toronto, London & Paris
KELLOGG PULLMAN



This U-tube bundle for a cracked gasoline stabilizer reboiler will soon see service in a small refinery in the Southwest.

The bundle, fabricated from 4-6% Cr, ½% Mo corrosion-resistant steel, is approximately 15 feet in length and will be inserted in a kettle type shell.

The unit is designed for temperatures up to 600°F on the tube side and 400°F on the shell side while processing corrosive materials. Design pressure on both sides is 250 psi.

# The *Purchasing Agent* Has Many HANDS

◆ He's one of the few guys around that's expected to be a crowd of people. Engineer . . . maintenance man . . . superintendent . . . machinist . . . operator. There can be no gaps in the know-how of the purchasing agent, so he recruits his extra hands from the corps of specialists which surround him. His signature on the check is backed by his ability to correlate the experience of many men.

Western Supply Company, manufacturers of heat exchangers for the refining, chemical, petrochemical and pipeline industries, has staked its reputation on the accurate and honest presentation of its equipment to the purchasing agent's advisors. As a result, plant men have come to rely on Western's integrity in the designing and building of all types of heat transfer equipment for all types of heat and pressure services.

Sales are often *made* by *talking*.

Confidence comes only through *experience*.

Purchasing agents throughout the world turn with *confidence* to Western for all their heat exchanger needs.

**In addition to their heat exchanger equipment, Western Supply Company offers the purchasing agent a complete supply of quality valves and fittings.**

**WESTERN**
***HEAT EXCHANGERS***

TEMA

*Manufactured by*
**WESTERN SUPPLY COMPANY**
P.O. BOX 1888 TULSA, OKLAHOMA

# New Chemical Dictionary Defines Generic and Proper Names

*The Van Nostrand Chemists Dictionary*, compiled by a board of editors; 6 x 9 in., iv + 761, stiff cloth cover, $10. D. Van Nostrand Co., 250 Fourth Ave., New York 3, N.Y.

IN THE WORDS of the editors, this chemical dictionary "is designed to provide the widest possible coverage of the terms in which chemists are most commonly interested." While not slanted for the specialist in any one field, the dictionary appears to give good general coverage in organic, inorganic analytical, and physical chemistry, as well as industrial chemistry and chemical engineering.

Terms defined include all the group terms of chemical substances, such as ion, radicals, type-compounds, etc. Also given are definitions of laws, reactions, mathematical equations and fundamental entities.

Perhaps the most attractive feature of the book is the manner in which definitions are made. First, both proper and common names are included for those processes, tests, etc. which can be defined either way. Secondly, a "key-word" plan is used. This involves defining each topic as far as possible in basic terms, with every word in that explanation which is further defined elsewhere in the book being printed in boldface type, making cross-definitions an easy matter.

Professors Jurgen M. Honig, Purdue University, S. Z. Lewin, New York University, and George Murphy, New York University, along with Dr. Morris B. Jacobs, New York City's Department of Air Pollution Control and William R. Minrath of the publishing firm, served as editors for the book.

Graphically, the book is quite well-done, with large, easy-to-read definitions, and well spaced and planned pages.

## Offer Monthly Digest Of German Patents

RESEARCH Information Service, publishers and translators of scientific data and foreign patent applications, is now offering subscriptions to complete monthly digests of German patent applications in the organic chemicals field.

Because of the spread of applications, digest subscriptions have been broken up into three categories at present. Class 12o includes hydrocarbons, alcohols, aldehydes, ketones, organic sulfur compounds, hydrogenated compounds, carboxylic acids, carboxylic acid amides, ureas and other compounds. Class 12p includes nitrogen rings, nitrogen-containing compounds of unknown structure. Class 12q includes amines, phenols, naphthols, aminophenols, aminonaphthols, aminoanthracene compounds, oxyanthracene compounds, oxygen, sulfur and selenium rings.

Class 12o costs $95 for six month's subscription, $175. per year. Class 12p costs $17.50 or $30. Class 12q costs $24. or $42. A combination rate for all three classes costs $130. for six months, $240. per year. Address Research Information Service at 53 Nassau St., New York, N. Y.

## New Reference Tables for Constantin Thermocouples

COVERING a broad range, from −310° to +1600° F., the new reference tables for iron-constantin thermocouples recently prepared by the National Bureau of Standards are said to correspond more closely with properties of commercially available thermocouples than any other similar tables now in use. The NBS tables are based on investigations carried out by R. J. Corruccini, Henry Shenker and other bureau members at the request of the Scientific Apparatus Makers of America.

SAMA has recommended the tables be adopted as a tentative standard.

## Discusses Foam Properties and Industrial Uses

*Foams: Theory and Industrial Applications*, by J. J. Bikerman and collaborators; 6 x 9 in., 347 pp., stiff cloth cover, $10. Reinhold Publishing Corp., 330 W. 42nd St., New York 36, N.Y.

THIS BOOK critically reviews the world literature on foams and offers an up-to-date treatment on its physical chemistry and industrial uses.

The first section, covering about three-quarters of the book, deals with the chemical and physical properties of foams, including chapters on formation and structure, methods of measurement, results of measurements, foam drainage, mechanical properties, optical properties, electrical properties, radius of molecular action and the theory of foams.

Succeeding chapters deal with fire-fighting foams, froth flotation, chemical antifoaming agents and other miscellaneous usages. These later chapters are prepared by Mr. Bikerman's collaborators, J. M. Perri, director of research for the National Foam Co., R. B. Booth, of the Mineral Dressing Laboratory of American Cyanamid Co., and C. C. Currie, manager of the fluids section section of Dow Corning Corp.'s product engineering section.

Literature references are given at the end of each chapter, and both an author and subject index are included.

## How Much Oil Behind The Iron Curtain?

*Oil in the Soviet Union*, by Heinrich Hassman, translated by Alfred M. Leeston; 6 x 9 in., xvi + 173 pp., stiff cloth cover, $3.75. Princeton University Press, Princeton, N.J.

BASICALLY, this is a geographic and economic review of the development of the petroleum industry in Russia from the days of the Czars through the revolution to the present mess. But there are so many gaps in the facts as to just what the Soviets have and how they are using it, that the author doesn't seem to be able to make any definite statements on what Russia's real war potential is in terms of oil products.

One fact is made apparent, and that has been obvious to most of the free world for a long time: Government direction and lack of private capital has hindered rather than helped the Russian oil industry.

## Publish Pipe and Tube Bending Manual

A WORKING manual which describes and illustrates the common methods of bending ferrous and non-ferrous pipe and tubing has recently been released by the Industrial Press Co. "Pipe and Tube Bending" by Paul B. Schubert, has been written for designers and engineers in many industrial fields, including chemical processing.

Descriptive information and data are so arranged that the reader can compare the various methods and become familiar with their respective advantages and limitations.

A large number of photographs and line diagrams, together with 15 tables, add to the book's worth as a practical manual. Price of the volume is $5., and it is obtainable from The Industrial Press, 148 Lafayette St., New York 13, N. Y.

# Study Chemical Plant Productivity At 46th AIChE Meeting in St. Louis

THREE general sessions as well as symposia on several problems of current interest to refinery and chemical processing engineers are on the bill of fare as the American Institute of Chemical Engineers completes arrangements for its 46th annual meeting, to be held at the Hotel Jefferson in St. Louis, December 13-16.

General sessions will cover such topics as performance of packed towers and bubble trays, ion exchange, a semi-commercial plant for resins and many other subjects. Symposia will be held on the following topics:

1—Productivity in chemical manufacturing, comprising the measurement of productivity and use of this concept in the chemical industry.

2—Processing of coal and oil shale, carbonization methods for coal and lignite, gasification of coal dust and retorting of oil shale.

3—Distillation, including factors influencing plate efficiency, batch rectification and mass transfer in distillation.

4—Industrial waste treatment, use of ion exchange in waste treatment, and catalytic oxidation of aqueous wastes.

5—Heat transfer in boiling liquids, liquid metals, fluidized beds, convective heat transfer, and heat transfer properties of liquid-solid suspensions.

6—Dust and mist collection, properties of dusts, mists and smokes, and performance of various types of collectors.

7—Fundamentals of digital computors, the functions of digital computors and the preparation of problems for these devices.

8—Drying, including theoretical aspects of the operation and performance of equipment.

Among other highlights at the meeting will be the awards banquet, at which various professional honors will be presented to this year's winners.

## *Talk Refinery Corrosion At NACE Regional Meet*

CORROSION problems affecting refineries, pipelines and aircraft will be the principal topics at the 3rd annual conference of the National Association of Corrosion Engineers, Western Region, November 19-20 at the Biltmore Hotel, Los Angeles. Petroleum refinery corrosion will be discussed on the afternoon of November 20.

The conference ties in with a three-day course in cathodic protection being offered by the University of California at Los Angeles under NACE sponsorship November 16-18.

## *24th Chemical Expo Begins Nov. 30 in Philly*

ALMOST five hundred exhibits, covering nearly five acres, will feature the 24th Exposition of Chemical Industries, getting underway November 30 at Philadelphia's Commercial Museum and Convention Hall.

Displays include chemical substances and materials, structural and protective materials and coatings, construction materials, chemical process equipment, production equipment, laboratory supplies, research and testing instruments and other apparatus used in chemical manufacture. Some 240 different classifications of exhibits are catalogued, with one to more than 100 exhibits in each class.

Chairman of the advisory committee for the 24th exposition is E. R. Weidlein, president of Mellon Institute. The show opens at 2 PM on Monday, November 30 running daily from 11 AM to 10 PM except on Wednesday, and closing on Saturday, December 5 at 6 PM.

## *Texas A & M Holds Process InstrumentationSymposium*

TEXAS A & M College will hold its 9th symposium on "Instrumentation for the Process Industries" January 27-29 at the campus in College Station, Texas. The symposium is sponsored annually on a cooperative basis with southwestern industrial firms and manufacturers of instruments and control equipment. Speakers are provided by these groups with new developments in instrumentation and control being displayed by manufacturers.

Additional details may be secured from Professor C. D. Holland, Chemical Engineering Department, Texas A & M College, College Station, Texas.

## *NCA Sets Jan. 12-14 As Annual Meet Date*

The National Constructors Association announces its annual meeting will be held January 12-14, 1954 at Hotel Commodore, New York City. The group is composed of leading industrial design and construction firms.

## The Oil Man's Calendar

NOVEMBER

*National Ass'n. of Corrosion Engineers*, 1953 Fall Conference of Western Region, Biltmore Hotel, Los Angeles, Nov. 19-20.

*Natural Gasoline Ass'n. of America*, regional meeting, Herring Hotel, Amarillo, Texas, Nov. 20.

*Chemical Industries Exposition*, Commercial Museum and Convention Hall, Philadelphia, Pa., Nov. 30-Dec. 5.

DECEMBER

*Corrosion Control Short Course*, under joint sponsorship of U. of Oklahoma and NACE, Norman, Okla., Dec. 1-4.

*Chemical Specialties Manufacturers Ass'n*, Annual meeting, Mayflower Hotel, Washington, D. C., Dec. 6-8.

*Scientific Apparatus Makers Ass'n*, laboratory apparatus, laboratory equipment and optical sections mid-year meeting, Boca Raton Club, Boca Raton, Fla., Dec. 7-10.

*American Chemical Society*, regional conclave, Juug Hotel, New Orleans, La., Dec. 10-12.

*American Institute of Chemical Engineers*, annual meeting, Hotel Jefferson, St. Louis, Mo., Dec. 13-16.

*American Chemical Society*, 1953 Symposium on "Flow Through Porous Media," University of Michigan, Ann Arbor, Dec. 28-29.

JANUARY, 1954

*Society of Automotive Engineers*, annual meeting and engineering exhibit, Sheraton-Cadillac and Statler Hotels, Detroit, Mich., Jan. 11-15.

*National Constructors Ass'n*, annual meeting, Commodore Hotel, New York City, Jan. 12-14.

*American Institute of Electrical Engineers*, winter general meeting, Statler Hotel, New York City, Jan. 18-22.

*Plant Maintenance and Engineering Show*, International Ampitheatre, Chicago, Ill., Jan. 25-28.

*Texas A & M College*, symposium on "Instrumentation for the Processing Industries", College Station, Texas, Jan. 27-29.

MARCH

*American Society for Testing Materials*, spring meeting, Hotel Shoreham, Washington, D. C., March 1-5.

*National Ass'n. of Corrosion Engineers*, 10th annual conference and exhibition, Kansas City Municipal Auditorium, Kansas City, Mo., March 15-19.

APRIL

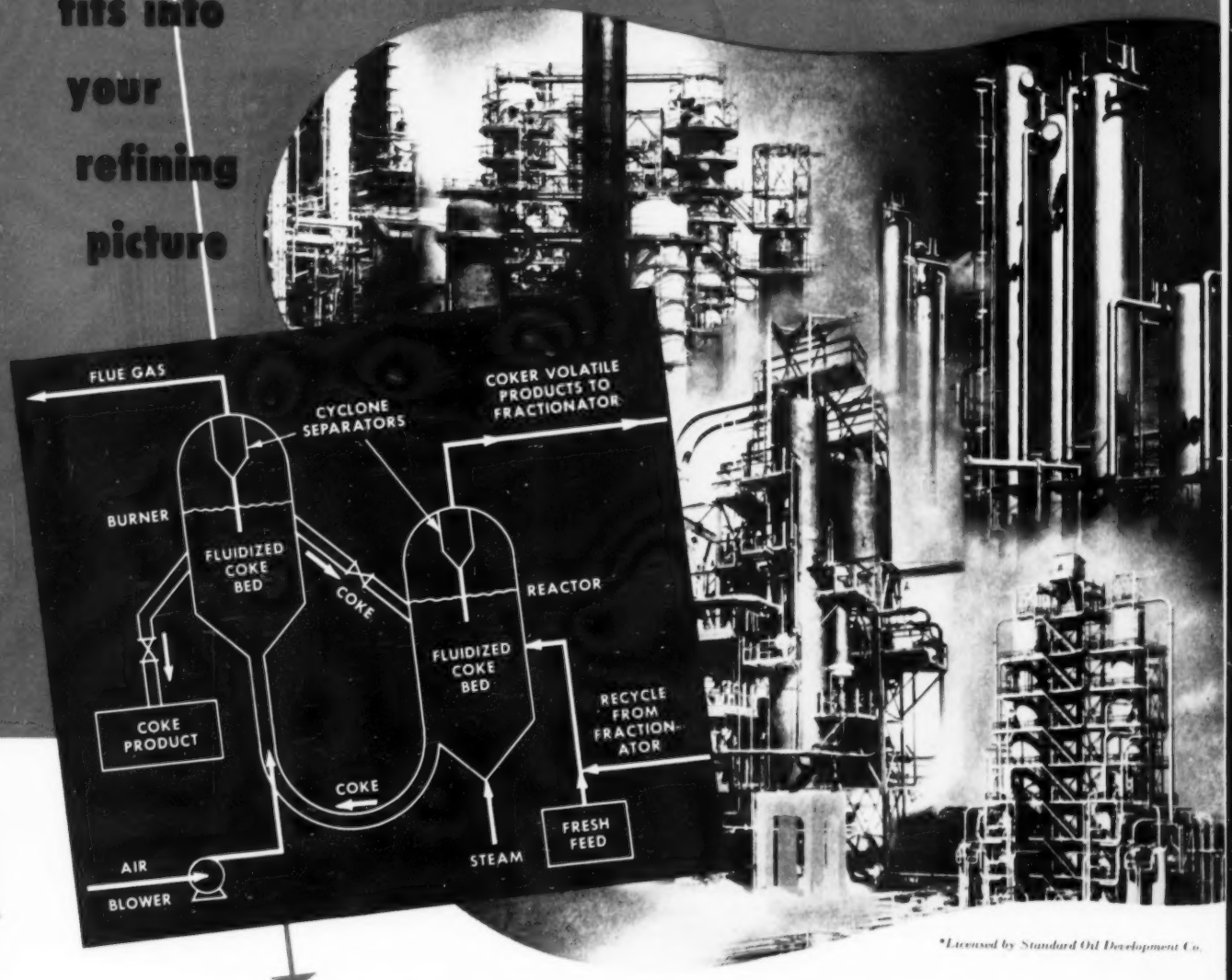
*National Petroleum Ass'n.*, 51st semi-annual meeting, Cleveland Hotel, Cleveland, Ohio, Apr. 14-16.

*Natural Gasoline Ass'n. of America*, 33rd annual convention, Baker Hotel, Dallas, Texas, Apr. 21-23.

MAY

*American Petroleum Institute, Division of Refining*, 19th mid-year meeting, Rice Hotel, Houston, Texas, May 10-13.

# Here's how FLUID COKING* fits into your refining picture




*Licensed by Standard Oil Development Co.

FLUID COKING makes profitable operations of processing low gravity crudes or residual stocks from other operations. In the preparation of catalytic cracking charge it results in a higher ultimate yield of gasoline. This new process permits charging a wide variety of feed stocks. It results in more liquid, less coke and virtually eliminates liquid residuum.

With its economical, continuous operation and low plant investment Fluid Coking will fit *profitably* into *your* refining picture.

• • •

*Call on McKee for facts and figures on Fluid Coking units. Our broad experience on all types of refining facilities is at your disposal.*

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*British representatives of Metals Division:* Head, Wrightson & Company, Ltd.
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# THIRTY-SEVEN YEARS and YOU

Thirty-seven years is a long time. Historians consider it a generation. Many things happen in that length of time to change our lives. The passing years add experience that guides our forward steps.

Since the start of our business, thirty-seven years ago, many changes have taken place here at Wolverine. Each has been a step forward—the natural result of experience that has been constantly furnishing the inspiration for us to keep looking ahead in search of better ways of doing things, in order that we may bring you the best tube products that human effort, skill, and modern equipment can provide.

Our efforts are not alone confined to the manufacture of tubing, but are also devoted to finding ways and means that will make your tube installations most efficient and profitable.

As tube specialists we are vitally interested in both the production of condenser tubing as well as its proper use in the field—counseling with the users as to the best alloy to use under their prevailing corrosion conditions. This applies to the use of copper, copper-base alloy, electric-welded steel and aluminum (2S and 3S) condenser tube.

In addition to prime surface condenser tube, Wolverine has also developed a unique finned tube for use in condensers—called Wolverine Trufin*—the integral finned tube. The specialized design of Trufin enables extended surface tube to be an economic standout in shell and tube heat exchanger installations.

Get the complete factual picture—ask for our condenser tube catalog.

*Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ontario.*

*REG. U. S. PAT. OFF.

**WOLVERINE TUBE DIVISION**
of CALUMET & HECLA, INC.

ESTABLISHED 1916

*Manufacturers of Quality-Controlled Tubing*

1425 CENTRAL AVENUE • DETROIT 9, MICHIGAN

Plants in Detroit, Mich. & Decatur, Ala. *Sales offices in Principal Cities*

# General Cuts Bring Crude Runs To Lowest Level Since April

**Outlook: Crude runs will be under 7,000,000 b/d avg. rest of the year . . . Gasoline demand easing as compared with a year ago . . . Heavy heating oil stocks in east indicate jobbers are still holding off buying their supplies . . . Large product stocks will carry over into '54.**

**RUNS to Stills:** Reductions by individual refiners in the volume of crude processed in their plants made itself felt in October, when runs averaged 6,881,000 b/d avg., about 2.8% less than runs in September. The various refining districts contributed about equally to the reduction. See Table 1.

This is the first brake on the momentum of refinery operations since the strike of '52 except for two brief intervals, the latest last April, and it remains to be seen if the causes which led to the current cuts in runs will make their influence felt the rest of this year. The independent Petroleum Assn. believes the brake will hold. Its latest supply-demand forecast estimates runs to stills in the U.S. in the last quarter will average 6,930,000 b/d, slightly less than actual runs of 6,961,000 b/d for the last quarter of '52. This is considerable change from the eight months of this year, when Petroleum Processing data shows runs were over 7% higher than the same period in '52, which included the curtailment in May due to the strike.

**Gasoline:** Gasoline demand at refineries is easing off as compared with the rate of gain over 1952 in earlier months. Indicated U. S. demand in September, 3,608,000 b/d avg., was 5.3% larger than September '52, and indicated October demand, 3,567,000 b/d avg. was 3.5% larger than in '52. For 9 months demand has been 7.5% larger than in '52. Gasoline demand in the last quarter, the IPAA estimates, will average 3,415,000 b/d, which is 3.6% above actual demand in the last quarter of '52. Demand for 1954 is forecast at 4% above estimated '53 demand.

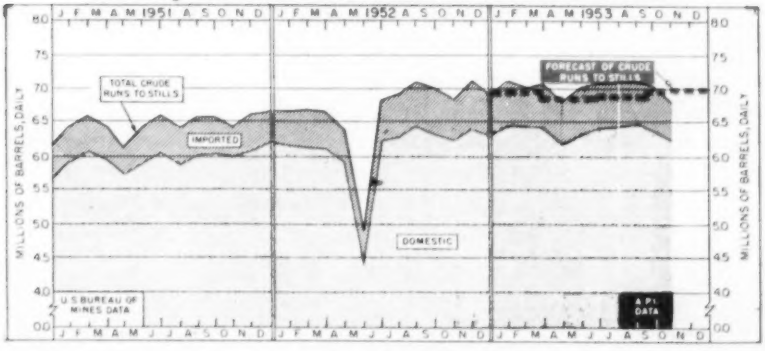
For the U. S. during September and early part of October, there were only nominal drafts on refiners' inventories of gasoline; but a year ago stocks built up around 3,700,000 bbls. in the same period. East of California the change in total inventories was nominal this year; last year stocks built up by over 4,000,000 bbls.

Refiners' total inventories of gasoline Oct. 24, 142,666,000 bbls., were 18% higher than the 120,767,000 bbls. held Oct. 25, '52. Due to large accumulations in California, East of California inventories were 122,824,000 bbls. Oct. 24, nearly 15.2% larger than the comparable 1952 date. Due to the larger buildup in stocks in the Okla.-Kans.-Mo. district and in some of the small inland districts, total inventories Oct. 24 were close to the total for the East Coast and Gulf Coast districts. On Oct. 25, '52 Coastal area stocks were about 3,000,000 bbls. larger than the total held in inland districts.

**Heating Oils:** Refiners' inventories of heating oils (kerosine and distillate fuels) do not properly reflect the coming supply-demand situation. For 9 months, demand at refineries has been only 3.2% larger than in '52. In September indicated demand of 1,404,000 b/d avg. was only 4.7% higher than last September and in October indicated demand at refineries was 1,547,000 b/d avg., 12.9% less than last October. With pre-season demand at this low rate, refiners' stocks have built up materially, particularly in the East and Gulf Coast districts and in Ind.-Ill.-Ky.

Total U. S. heating oil stocks Oct. 24 were 170,161,000 bbls., 8% higher than the 156,320,000 bbls. held Oct. 25, 1952. East of California stocks of 155,034,000 bbls. were about 8% higher than the 142,460,000 bbls. of the year before. East and Gulf Coast inventories were about 10% higher on Oct. 24 and in Ind.-Ill.-Ky. refiners' stocks were over 10% greater. The high inventories in these areas reflect the lack of normal buying by heating oil distributors to date. With a 7% increase in demand forecast for the last quarter, the first cold spell may see a pull on refiners' inventories, in these districts particularly.

## Heavy Stocks Push Down Runs to Stills




## Table 1—How Crude Runs to Stills Have Been Reduced by Refinery Districts

(1000 Bbls.—Daily Average)

| | 4 weeks October | 4 weeks Sept. | Change Oct. Over Sept. |
|---|---|---|---|
| East Coast | 1,020 | 1,060 | —40 |
| Gulf Coast | 2,185 | 2,251 | —66 |
| Total Coastal | 3,205 | 3,311 | —106 |
| Appalachian | 193 | 186 | +7 |
| Ind.-Ill.-Ky | 1,263 | 1,286 | —23 |
| Okla.-Kans.-Mo. | 577 | 591 | —14 |
| Other inland | 595 | 623 | —28 |
| Total Inland | 2,628 | 2,686 | —58 |
| Total East of Cal. | 5,833 | 5,997 | —164 |
| California | 1,048 | 1,082 | —34 |
| Total U. S. | 6,881 | 7,079 | —198 |

## Crude Runs to Stills

Daily Average (1000 bbls.)

| | Domestic | Foreign | TOTAL |
|---|---|---|---|
| Oct. '53 API* | 6,237 | 644 | 6,881 |
| Oct. '52 BM | 6,275 | 608 | 6,883 |
| Change | —38 | +36 | —2 |
| % Change | 0.6 | 5.9 | |

* Through Oct. 24

Total (1000 bbls.)

(Bureau of Mines Data)

| | | | |
|---|---|---|---|
| 9 mos. '53 | 1,741,500 | 174,411 | 1,915,911 |
| 9 mos. '52 | 1,650,975 | 149,966 | 1,800,941 |
| Change | +90,525 | +24,445 | +114,970 |
| % Change | 5.5 | 16.2 | 6.4 |

* Aug. & Sept. estimated from API data.

Data on Crude Runs to Stills, 1953

(July 30, 1953; 1000 b/d avg. by quarters)

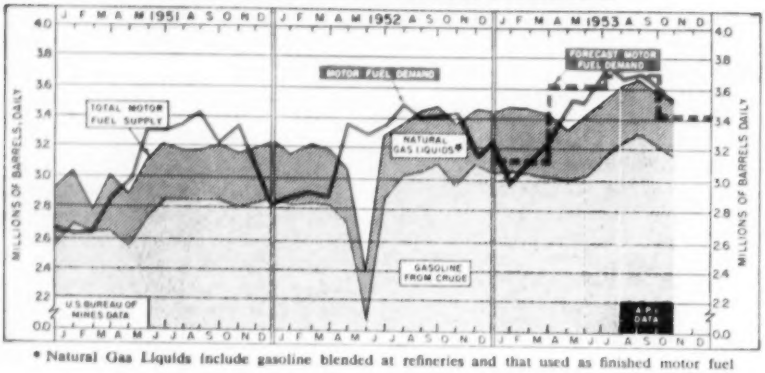
| Actual | Estimated | Forecast |
|---|---|---|
| 1st Q. 7,006 | 2nd Q. 6,959 | 3d Q. 6,991 4th Q. 7,044 |

## Yields on Crude Runs to Stills

| | Gasoline % | Kerosine % | Dist. Fuels % | Resid. Fuels % |
|---|---|---|---|---|
| Oct. '53 API* | 46.2 | 5.2 | 21.3 | 17.5 |
| Sept. '53 API | 45.6 | 4.6 | 20.3 | 17.4 |
| Aug. '53 API | 46.3 | 4.5 | 20.3 | 17.3 |
| Oct. '52 BM | 43.9 | 5.1 | 21.2 | 17.5 |

*Through Oct. 24.

## Motor Fuel Production Reduced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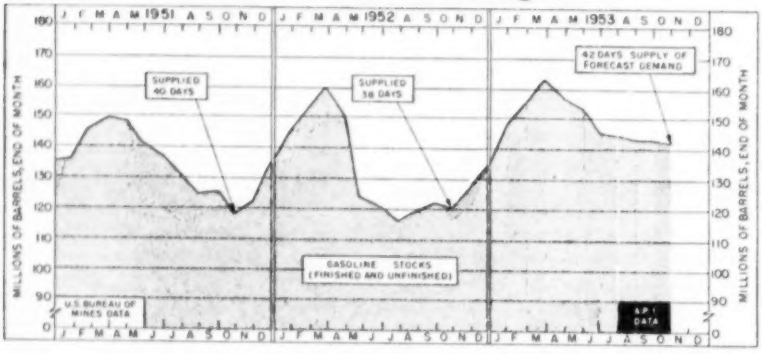
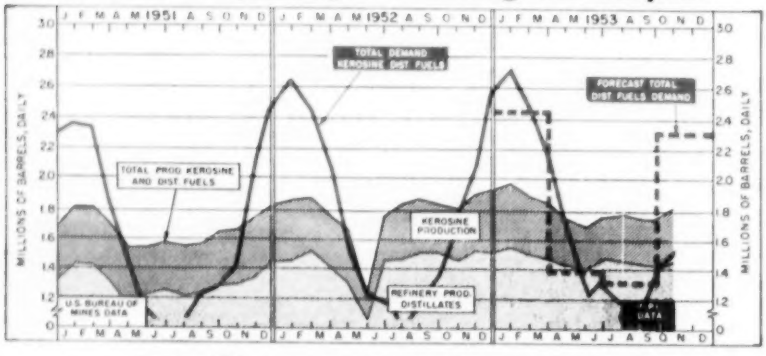
J F M A M 1952 A S O N D
J F M A M 1953 A S O N D
MILLIONS OF BARRELS, DAILY
TOTAL MOTOR FUEL SUPPLY
MOTOR FUEL DEMAND
FORECAST MOTOR FUEL DEMAND
NATURAL GAS LIQUIDS*
GASOLINE FROM CRUDE
U.S. BUREAU OF MINES DATA
A.P.I. DATA

* Natural Gas Liquids include gasoline blended at refineries and that used as finished motor fuel

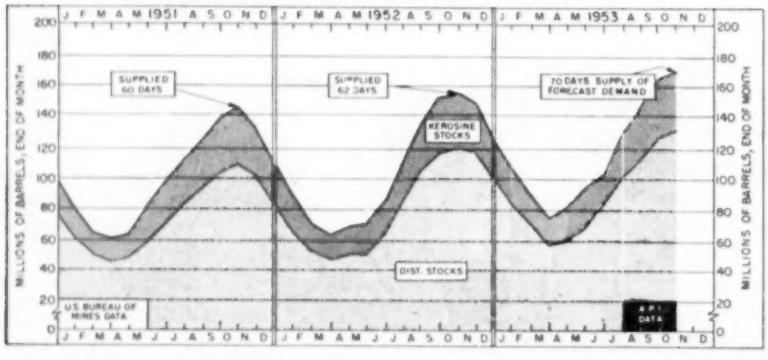
## Gasoline Stocks Leveling Off


J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
J F M A M 1953 A S O N D
MILLIONS OF BARRELS, END OF MONTH
SUPPLIED 40 DAYS
SUPPLIED 38 DAYS
42 DAYS SUPPLY OF FORECAST DEMAND
GASOLINE STOCKS (FINISHED AND UNFINISHED)
U.S. BUREAU OF MINES DATA
A.P.I. DATA

## Seasonal Upswing in Heating Oil Output


J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
J F M A M 1953 A S O N D
MILLIONS OF BARRELS, DAILY
TOTAL DEMAND KEROSINE DIST. FUELS
FORECAST TOTAL DIST. FUELS DEMAND
TOTAL PROD. KEROSINE AND DIST. FUELS
KEROSINE PRODUCTION
REFINERY PROD. DISTILLATES
U.S. BUREAU OF MINES DATA
A.P.I. DATA

## Distillate Stocks at New Peak


J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
J F M A M 1953 A S O N D
MILLIONS OF BARRELS, END OF MONTH
SUPPLIED 60 DAYS
SUPPLIED 62 DAYS
70 DAYS SUPPLY OF FORECAST DEMAND
KEROSINE STOCKS
DIST. STOCKS
U.S. BUREAU OF MINES DATA
A.P.I. DATA

## Motor Fuel Supply

**Daily Average (1000 bbls.)**

| | Gasoline from Crude | Natural Blended Used Direct | TOTAL |
|---|---|---|---|
| Oct. '53 API* | 3,177 | 380 | 3,557 |
| Oct. '52 BM | 2,986 | 397 | 3,383 |
| Change | +191 | −17 | +174 |
| % Change | 6.4 | 4.3 | 5.1 |

* Through Oct. 24.

**Total (1000 bbls.)**
(Bureau of Mines Data)

| | | | |
|---|---|---|---|
| 9 Mos. '53* | 857,698 | 103,207 | 960,905 |
| 9 Mos. '52 | 771,558 | 102,024 | 873,582 |
| Change | +86,140 | +1,183 | +87,323 |
| % Change | 11.2 | 1.2 | 10.0 |

*Aug. & Sept. estimated from API data.

## Motor Fuel Demand

**Including Exports**
**Daily Average (1000 bbls.)**

| | |
|---|---|
| Oct. '53 API* | 3,567 |
| Oct. '52 BM | 3,447 |
| Change | +120 |
| % Change | 3.5 |

* Through Oct. 24.

**Total (1000 bbls.)**
(Bureau of Mines Data)

| | |
|---|---|
| 9 Mos. '53 | 954,086 |
| 9 Mos. '52 | 887,858 |
| Change | +66,228 |
| % Change | 7.5 |

*Aug. & Sept. estimated from API data.

**BM Data on Motor Fuel Demand, 1953**
(July 30, 1953; 1000 b/d avg. by quarters)

| Actual | Estimated | Forecast |
|---|---|---|
| 1st Q., 3,150 | 2nd Q., 3,610 | 3d Q., 3,674 | 4th Q., 3,435 |

## Gasoline Stocks

**Finished and unfinished, end of month (1000 bbls.)**

| | |
|---|---|
| Oct. '53 API* | 142,666 |
| Sept. '53 API | 142,904 |
| Aug. '53 API | 143,548 |
| Oct. '52 BM | 120,062 |

*Oct. 24.

## Heating Oils Production

**(Kerosine and Distillates)**
**Daily Average (1000 bbls.)**

| | Kerosine | Dist. Fuels | TOTAL |
|---|---|---|---|
| Oct. '53 API* | 360 | 1,452 | 1,812 |
| Oct. '52 BM | 352 | 1,458 | 1,810 |
| Change | +8 | −6 | +2 |
| % Change | 2.3 | 0.4 | |

* Through Oct. 24.

**Total (1000 bbls.)**
(Bureau of Mines Data)

| | | | |
|---|---|---|---|
| 9 Mos. '53* | 96,309 | 398,204 | 494,513 |
| 9 Mos. '52 | 96,528 | 384,003 | 480,531 |
| Change | −219 | +14,201 | +13,982 |
| % Change | 6.2 | 3.7 | 2.9 |

*Aug. & Sept. estimated from API data.

## Heating Oils Demand

**Daily Average (1000 bbls.)**

| | Kerosine | Dist. Fuels | TOTAL |
|---|---|---|---|
| Oct. '53 API* | 348 | 1,199 | 1,547 |
| Oct. '52 BM | 409 | 1,368 | 1,777 |
| Change | −61 | −169 | −230 |
| % Change | 14.9 | 12.4 | 12.9 |

* Through Oct. 24.

**Total (1000 bbls.)**
(Bureau of Mines Data)

| | | | |
|---|---|---|---|
| 9 Mos. '53* | 86,253 | 373,940 | 460,193 |
| 9 Mos. '52 | 88,595 | 357,145 | 445,740 |
| Change | −2,312 | +16,795 | +14,453 |
| % Change | 2.6 | 4.6 | 3.2 |

*Aug. & Sept. estimated from API data.

**BM Data on Heating Oils Demand, 1953**
(July 30, 1953; 1000 b/d avg. by quarters)

| Actual | Estimated | Forecast |
|---|---|---|
| 1st Q., 2,459 | 2nd Q., 1,398 | 3d Q., 1,283 | 4th Q., 2,321 |

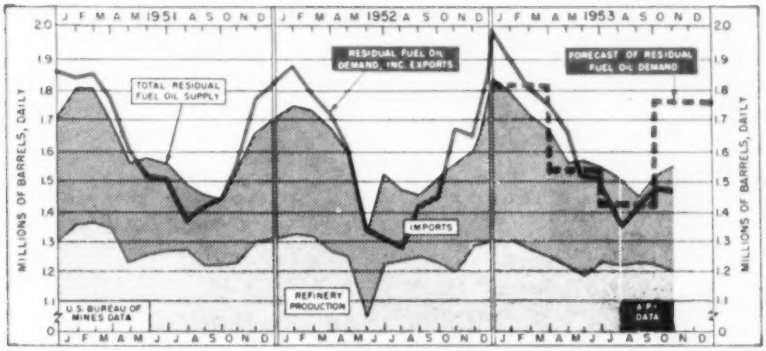
## Heating Oil Stocks

**(1000 bbls. end of month)**

| | Kerosine | Dist. Fuels | TOTAL |
|---|---|---|---|
| Oct. '53 API* | 37,394 | 132,767 | 170,161 |
| Sept. '53 API | 37,116 | 126,693 | 163,809 |
| Aug. '53 API | 35,061 | 118,158 | 153,219 |
| Oct. '52 BM | 33,289 | 120,721 | 154,010 |

*Oct. 24.

## Residual Demand Unseasonally Light


J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
J F M A M 1953 A S O N D
MILLIONS OF BARRELS, DAILY
TOTAL RESIDUAL FUEL OIL SUPPLY
RESIDUAL FUEL OIL DEMAND, INC. EXPORTS
FORECAST OF RESIDUAL FUEL OIL DEMAND
IMPORTS
REFINERY PRODUCTION
U.S. BUREAU OF MINES DATA
A.P.I. DATA

### Residual Fuels Production

Daily Average (1000 bbls.)

| | Refinery Output | Imports | TOTAL |
|---|---|---|---|
| Oct. '53 API* | 1,184 | 317 | 1,501 |
| Oct. '52 BM | 1,203 | 366 | 1,569 |
| Change | −19 | −49 | −68 |
| % Change | 1.6 | 13.4 | 4.3 |

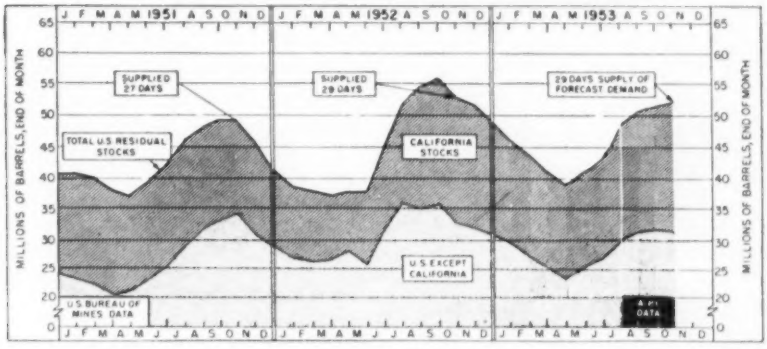
* Through Oct. 24.

Total (1000 bbls.)
(Bureau of Mines Data)

| | | | |
|---|---|---|---|
| 9 Mos. '53* | 339,531 | 99,316 | 438,847 |
| 9 Mos. '52 | 338,128 | 90,954 | 429,082 |
| Change | +1,403 | +8,362 | +9,765 |
| % Change | 0.4 | 9.2 | 2.3 |

*Aug. & Sept. estimated from API data.

## Eastern Residual Stocks Unchanged


J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
J F M A M 1953 A S O N D
MILLIONS OF BARRELS, END OF MONTH
SUPPLIED 27 DAYS
SUPPLIED 29 DAYS
29 DAYS SUPPLY OF FORECAST DEMAND
TOTAL U.S. RESIDUAL STOCKS
CALIFORNIA STOCKS
U.S. EXCEPT CALIFORNIA
U.S. BUREAU OF MINES DATA
A.P.I. DATA

### Residual Fuels Demand

Daily Average (1000 bbls.)

| | |
|---|---|
| Oct. '53 API* | 1,471 |
| Oct. '52 BM | 1,688 |
| Change | −217 |
| % Change | 12.9 |

* Through Oct. 24.

Total Demand (1000 bbls.)

| | |
|---|---|
| 8 Mos. '53* | 439,791 |
| 9 Mos. '52 | 420,542 |
| Change | +19,249 |
| % Change | 4.3 |

*Aug. & Sept. estimated from API data.

BM Data on Residual Fuels Demand, 1953
(July 30, 1953; 1000 b/d avg. by quarters)

| Actual | Estimated | Forecast |
|---|---|---|
| 1st Q., 1,833 | 2nd Q., 1,542 | 3d Q., 1,429 4th Q., 1,703 |

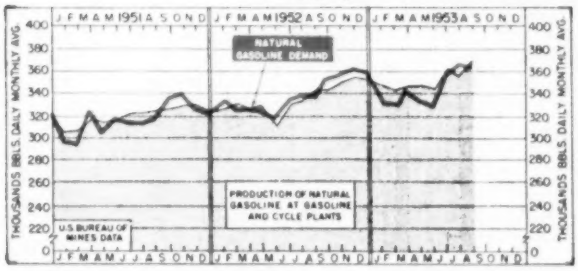
### Residual Fuel Stocks

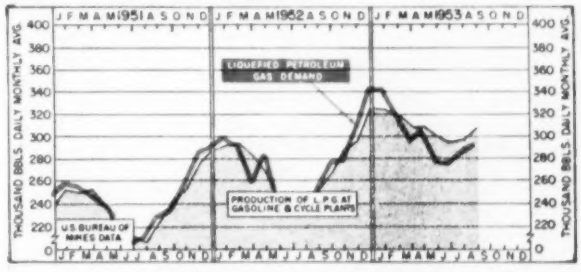
1000 bbls. end of month

| | U.S. Except California | TOTAL U.S. |
|---|---|---|
| Oct. '53 API* | 31,233 | 52,633 |
| Sept. '53 API | 31,304 | 51,922 |
| Aug. '53 API | 31,370 | 50,926 |
| Oct. '52 BM | 33,559 | 53,052 |

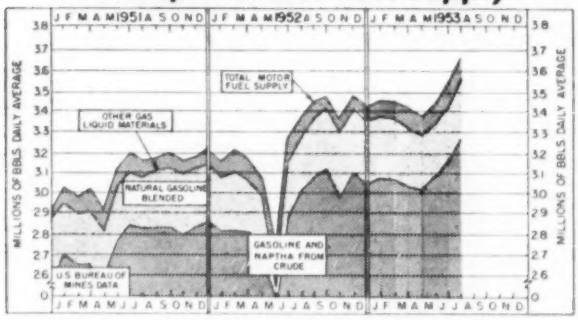
*Oct. 21.

## Supply and Demand of Natural Gas Liquids


J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
J F M A M 1953 A S O N D
THOUSANDS BBLS DAILY MONTHLY AVG.
NATURAL GASOLINE DEMAND
PRODUCTION OF NATURAL GASOLINE AT GASOLINE AND CYCLE PLANTS
U.S. BUREAU OF MINES DATA


J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
J F M A M 1953 A S O N D
THOUSAND BBLS DAILY MONTHLY AVG.
LIQUEFIED PETROLEUM GAS DEMAND
PRODUCTION OF L.P.G. AT GASOLINE & CYCLE PLANTS
U.S. BUREAU OF MINES DATA

## Makeup of Motor Fuel Supply


J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
J F M A M 1953 A S O N D
MILLIONS OF BBLS. DAILY AVERAGE
TOTAL MOTOR FUEL SUPPLY
OTHER GAS LIQUID MATERIALS
NATURAL GASOLINE BLENDED
GASOLINE AND NAPTHA FROM CRUDE
U.S. BUREAU OF MINES DATA

(Figures in table in 1000 bbls./day average)

| | Gasoline & Naphtha from Crude | Natural Blended | Other Gas Liquid Materials | Total Motor Fuel Supply |
|---|---|---|---|---|
| July '53 | 3,276 | 307 | 98 | 3,681 |
| June '53 | 3,168 | 298 | 99 | 3,565 |
| May '53 | 3,100 | 266 | 93 | 3,459 |
| July '52 | 3,012 | 283 | 93 | 3,388 |

### Natural Gas Liquids Statistics

(Source: U.S. Bureau of Mines Report on Natural Gasoline and Cycle Plant Operations)

| | Supply* (1000 bbls./day Avg.) Natural Gasoline | LPG | TOTAL | Demand** (1000 bbls./day avg.) Natural Gasoline | LPG | TOTAL |
|---|---|---|---|---|---|---|
| Aug. '53* | 368 | 307 | 675 | 361 | 292 | 653 |
| Aug. '52 | 341 | 251 | 592 | 336 | 249 | 585 |
| Change | +27 | +56 | +83 | +25 | +43 | +68 |
| % Change | 7.9 | 22.3 | 14.0 | 7.4 | 17.3 | 11.5 |
| | Total Supply (1000 bbls.) | | | Total Demand (1000 bbls.) | | |
| 8 Mos. '53* | 85,381 | 74,758 | 160,139 | 84,037 | 72,911 | 156,948 |
| 8 Mos. '52 | 80,358 | 64,587 | 144,945 | 80,149 | 63,054 | 143,203 |
| Change | +5,023 | +10,171 | +15,194 | +3,888 | +9,857 | +13,745 |
| % Change | 6.2 | 15.7 | 10.5 | 4.8 | 15.6 | 9.6 |

| | Stocks, End of Month (1000 bbls.) By Type of product (At gasoline plants and terminals only) LPG | Natural Gasoline | Con-densate | Finished Gasoline† | By Location Gasoline Plants | Refineries | Total |
|---|---|---|---|---|---|---|---|
| Aug. '53 | 4,038 | 3,492 | 264 | 1,121 | 8,915 | 3,044 | 11,959 |
| July '53 | 3,579 | 3,340 | 290 | 1,041 | 8,250 | 3,003 | 11,253 |
| June '53 | 3,155 | 3,602 | 255 | 1,030 | 8,042 | 3,012 | 11,054 |
| June '52 | 2,895 | 2,858 | 261 | 1,162 | 7,086 | 2,636 | 9,722 |

* Supply includes receipts from refineries as well as current production from natural gasoline and cycling plants. Receipts from refineries in August included 321,000 bbls. of natural gasoline.

** Demand does not include liquefied refinery gases produced for fuel and chemical purposes, which totaled 2,958,000 bbls. in August.

† Includes naphtha and other products.

# Information Offered in the Advertisements

*Do you need detailed information on a specific subject? Check through this easy-to-use index of literature and data being offered in this issue's advertisements.*

ADDITIVES, for furnace oils, rust inhibiting: Data and samples; Oronite Chemical Co. See adv't p. 1660.

ADDITIVES, for gear lubricants: Information on Santopoid 33; Monsanto Chemical Co. See adv't p. 1667.

ADDITIVES, sludge dispersant, for distillate heating oils and diesel fuels: "Driacin" samples and literature; Universal Oil Products Co. See adv't p. 1742.

AIR PREHEATERS: Complete details; The Air Preheater Corp. See adv't p. 1644.

ANNUNCIATOR SYSTEMS, for instrumentation: Catalog 100-A; Panalarm Products, Inc. See adv't p. 1733.

BUBBLE CAPS, choice of alloys: Catalog 52; The Pressed Steel Co. See adv't p. 1769.

CATALYST SUPPORTS, refractory type: Free samples; Norton Co. See adv't p. 1648.

CATALYTIC REFORMING: Book on Atlantic "Catforming"; The Atlantic Refining Co. See Adv't pps. 1668-1669.

COOLING TOWER FANS: Bulletin 1503; Hartzell Propeller Fan Co. See adv't p. 1618.

CORROSION ANSWERS, by use of nickel alloys: Bulletin on hydrofluoric acid; The International Nickel Co., Inc. See adv't p. 1657.

ELECTRICAL MOTORS, dial control; variable drive: "Varidrive" bulletin; U. S. Electrical Motors Inc. See adv't p. 1789.

EXPANSION JOINTS: Bulletin 351; Zallea Brothers. See adv't p. 1656.

EXPANSION JOINTS, ball bearing swivel: Catalog 53-C; Chiksan Co. See adv't p. 1661.

FITTINGS, seamless welding: Catalog; Globe Steel Tubes Co. See adv't facing p. 1712.

STEAM TRAPS: "Duo-Step" brochure; Clark Manufacturing Co. See adv't p. 1734.

STEAM TRAPS, impulse type: "Steam Trap Selector"; Yarnall-Waring Co. See adv't p. 1775.

STEAM TRAPS, expansion type: Catalog 953; W. H. Nicholson & Co. See adv't p. 1770.

STEAM TURBINES, multi-stage, general-purpose: Information; Westinghouse Electric Corp. See adv't p. 1674.

SULFONATES, petroleum, free flowing: Technical data; L. Sonneborn Sons, Inc. See adv't p. 1776.

TANK CLEANING, with chemicals: Details, including blueprints; Oakite Products, Inc. See adv't p. 1778.

TEMPERATURE RECORDER, multipoint: Bulletin 427-1; The Foxboro Co. See adv't p. 1731.

TEMPERATURE RECORDER, pneumatic receiver, multi-point: Bulletin 444; The Foxboro Co. See adv't p. 1731.

THERMOMETER, mercury actuated, dial type: Bulletin 51-129; Palmer Thermometers, Inc. See adv't p. 1738.

TUBE CLEANER, and expanders: Bulletin No. 54; Airetool Manufacturing Co. See adv't p. 1766.

TUBE FITTINGS, brass, aluminum, steel, stainless steel and monel: Swagelok catalog; Crawford Fitting Co. See adv't p. 1788.

TURBINES, steam, mechanical-drive: Bulletin GEA-4955A; General Electric Co. See adv't pps. 1658-1659.

VALVES, gate, screwed, flanged, or socket-welding: Crane catalog; Crane Co. See adv't p. 1636.

VALVES, plug: "Valve Reference Book No. 39-3;" Homestead Valve Manufacturing Co. See adv't p. 1768.

WATER SEPARATORS: Process Manual R-101-53; Warner Lewis Co. See adv't p. 1781.

PUMPS, controlled volume, air-powered: Bulletin No. 351; Milton Roy Co. See adv't p. 1640.

FLUID COKING: Information on first cost, utilities, operation, design, and construction data; Foster-Wheeler Corp. See adv't p. 1664.

HEAT EXCHANGERS, shell and tube type: Bulletin HE-6; Henry Vogt Machine Co. See adv't p. 1777.

HEAT EXCHANGER TUBES, copper alloy: Publication B-2; The American Brass Co. See adv't p. 1649.

INFRARED SPECTROPHOTOMETER: Data File 92-23; Beckman Instruments, Inc. See adv't p. 1732.

INHIBITORS, for prevention of gum formation in motor fuels: Booklets on the "Tenamenes"; Tennessee Eastman Co. See adv't p. 1637.

INSTRUMENT CHARTS, for recording: Catalog; Technical Charts, Inc. See adv't p. 1785.

INSTRUMENT PANELS, graphic: Bulletin 85-20, "Centralized Instrumentation—unlimited"; Minneapolis-Honeywell Regulator Co. See adv't pps. 1672-1673.

INSTRUMENTS, for laboratory testing: Bulletin No. 50; Refinery Supply Co. See adv't p. 1785.

LEVEL INDICATOR, recorder, and control, electronic; Three data bulletins; Fielden Instrument Division, Robertshaw-Fulton Controls Co. See adv't p. 1739.

LIQUID LEVEL CONTROLLER, electronic: Detailed information; Instruments, Inc. See adv't p. 1785.

MIXERS, all types: Seven catalogs; Mixing Equipment Co., Inc. See adv't p. 1684.

OXYGEN ANALYZER: Bulletin 52-829-56; The Hays Corp. See adv't p. 1626.

PRESSURE GAGES, non-spill, mercury type: Bulletin 3; The Meriam Instrument Co. See adv't p. 1789.

PUMPS, centrifugal, made of bronze alloys: Literature; Ampco Metal, Inc. See adv't pps. 1652-1653.

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# ADVERTISER'S INDEX

**FOR INFORMATION ON ANY PRODUCT OR SERVICE ADVERTISED IN THIS ISSUE SEE INSTRUCTIONS BELOW**

**Each advertiser listed in this index has been assigned a code letter for use by the reader in securing additional information about advertised products or services which interest him. This code letter appears in parentheses to the left of the advertiser's name.**

**Circle the code letter on the "Advertised Product Inquiry" card (on the page opposite) which corresponds to that assigned the advertiser about whose product you want further information.**

**Fill in your name, title, company and mailing address and mail the card . . . no postage is required.**

**The Petroleum Processing Reader Service Department will give your inquiries prompt and efficient handling.**


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(A-2) Air Preheater Corp. ..... 1644
(E-2) Allied Chemical & Dye Corp., General Chemical Div. Inside Back Cover
(A-3) American Locomotive Co. ...1662, 1663
(A-4) Ampco Metal, Inc. .....1652, 1653
(A-5) Anaconda Copper Mining Co. .... 1649
(A-6) Anderson Co., The V. D. ..... 1675
(A-7) Atlantic Refining Co. .....1668, 1669
(A-8) Badger Mfg. Co. ..... 1784
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(E-8) Harshaw Chemical Co. .... Facing 1649
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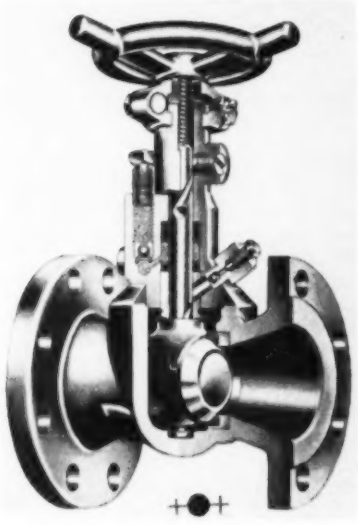
(L-8) Yarnall-Waring Co. ..... 1775
(L-9) York Co., Inc., Otto H. ..... 1740
(M-1) Young Radiator Co. ..... 1779
(M-2) Zallea Brothers ..... 1656

# WHAT'S NEW . . .



### LP Gas Valve Has No Voids in the Body

. . . to trap fluids. Vapor leaks are eliminated due to welding the forged steel body and bonnet into one pressure vessel. Orbit Venturi valves are available with flanged end only, carbon trim and stainless trim, and ring joint and raised face. All have maximum ratings of 250° F. The units have rising stems which enable operators to tell if the valve is in an open or closed position. In the ASA class, Venturi valves are available in 150, 300, 400, 600, 900, 1500, 2500 lb. sizes, in a variety of valve openings. Orbit Valve Co., Tulsa, Okla.

*Circle No.* **1** *on Reply Card*

### Counting Instrument Has Provision for Plug-In

. . . units which convert the scaler into a variety of specialized instruments. Each plug-in unit is mounted on a miniature chassis which can be plugged directly into the front panel of "Superscaler". Now available are a pulse amplifier, a ratemeter, a discriminator and a blank chassis which make it possible for users of the unit to construct their own special circuits to precede or follow the scaler. The unit is said to be a fast and reliable counting instrument for Geiger, proportional or scintillation pulses, featuring both preset count and preset time operation. It is equipped with three SC-41 Plug-In Decascales which provide an electronic scaling factor of 1000, a mechanical register, an odometer-type timer, and high voltage power supply. Register follows the scales in the 1000 positions, and can totalize up to 9999 impulses enabling a total count of up to 10,000,000. The unit has been constructed to operated with the company's Automatic Sample Changer and Tracergraph for fully automatic sample counting. Tracerlab, Inc., 130 High St., Boston 10, Mass.

*Circle No.* **2** *on Reply Card*

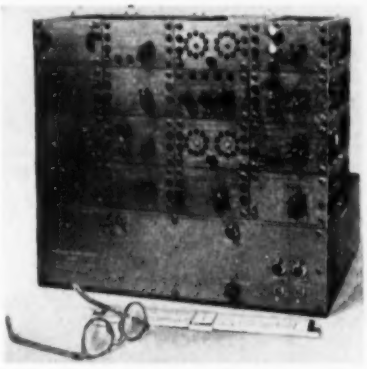
**For More Information**

Use one of the attached reply cards to request additional details or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the rest of the card and drop it in the mail. No postage is required.

### Analog Computer Component Converts Rotation Movements

. . . into linear sine or cosine movements. Sine-Cosine Mechanism is said to offer instantaneous solutions to problems of changing variables involving vector components, range and bearing computation and other trigonometric functions. Features include pre-set indexing, low friction, and simplicity of design in a completely self-contained unit. Stroke is .750 ± .0015 in. each side of zero. Librascope, Inc., 1607 Flower St., Glendale, Calif.

*Circle No.* **3** *on Reply Card*



### Pulse System Performs All Basic Data Functions

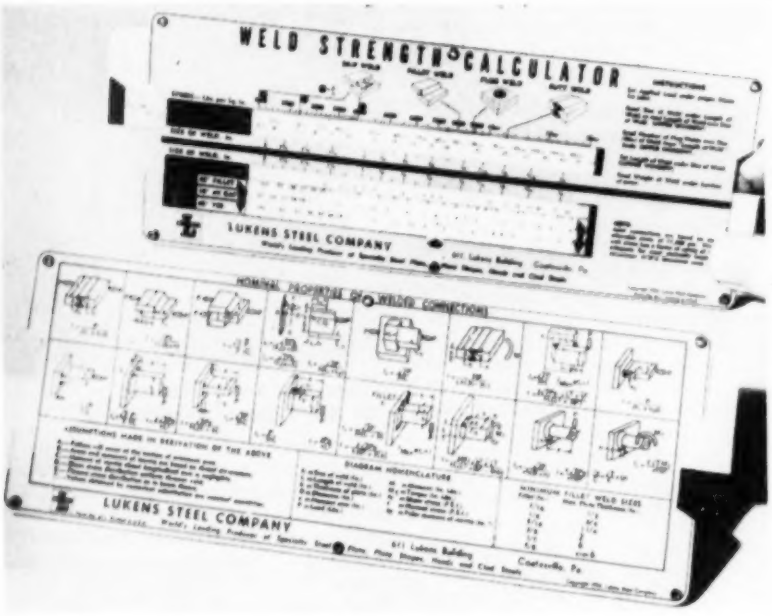
. . . such as gating, pulse forming, counting, coincidence marking, etc., as well as simpler electronic tasks like amplification, signal inversion and impedence matching. Called the "Modular System" of digital pulse units, the system consists of 16 electrically and mechanically compatible "Modulars". These are linked together by mechanical means and interconnected with patch cords. Since each unit performs a multiplicity of independent functions selectively, a complete system of 16 units and a regulated power supply has a capability of 72 separate functions with as many as 31 functions simultaneously available. Simple digital instruments such as time interval meters, complex high speed electronic switches, stylized pulse generators, etc., can be patched up quickly by using the system. Individual units are 2¾-in. high, 4½-in. wide and 9-in. long. Audio Products Corp., Los Angeles, Calif.

*Circle No.* **4** *on Reply Card*

### Electronic Level Control Has No Moving Parts

. . . giving control as close as 1/16 in. of liquid, divided solid, interface, conducting or non-conducting, wet or dry materials. Tektor operates by a change in the electrical capacitance of the electrode caused by the approach of any material that flows. Electrodes are rigid rods or discs which may be completely sheathed in corrosion-resistant material. They are available for use with pressures up to 2000 psi, temperatures up to 1500° F. New features include trimmer adjustment, and accessibility without removing cover for simpler installation and set-up. Only a single radio tube is employed, and operation is on 115 volt, 60 cycle power. Robertshaw-Fulton Controls Co., Philadelphia, Pa.

*Circle No.* **5** *on Reply Card*




## Calculator Figures Welding Stresses

A weld strength calculator which gives values for stresses ranging from 2,000 to 20,000 psi., and applied loads of from 9,000 to 450,000 lb., has been made available to engineers and designers concerned with steel plate fabrication.

A companion tool to the manufacturer's plate size selector, the instrument is a durably-made plastic slide rule which indicates both size of weld needed for a given applied load, and the weight of a given length of weld in lbs.

On the reverse side of the calculator are basic design data for welded connections, plus formulas for calculating nominal properties of welded connections. Lukens Steel Co., Coatesville, Pa.

*Circle No.* **6** *on Reply Card*

### Mass Spectrometer Uses New Principle

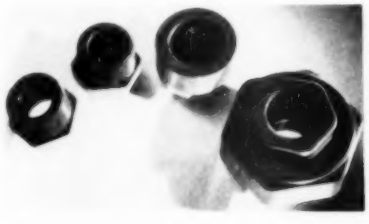
. . . of ion resonance. Specially designed to meet process requirements in the gas, petroleum and chemical fields, the instrument has, in addition, a sample inlet system to allow direct connection to a stream or process line, allowing continuous sample introduction. A programming device incorporated into the unit allows automatic and repetitive continuous scanning of the spectrum, manual scanning or selection of peak or peaks of a given mass, and with minor modification, automatic monitoring of one or more peaks in sequence. Operation covers approximate range of 1 to 100 mass units. In this spectrometer, ions are formed within the magnetic field instead of a separate ion chamber. Ions of a specific mass follow a spiral path to a collector by applying a super-imposed, radio-frequency, electrostatic field. By controlling frequency, only ions of a definite m/r follow the spiral path while all others are drawn out of the analyzing region. Thus the signal received by the collector indicates the quantity and mass of ions present. As frequency is varied, the complete spectrum is observed. Output of the instrument can be read directly on a large meter, or can be supplied to additional external recording equipment. The unit consists of a single 750 lb. cabinet, approximately 24-in. wide, 30-in. deep and 47-in. high. A diffusion pump incorporated in the equipment requires two to five gal./hr. of water for cooling purposes. General Electric, Schenectady 5, N. Y.

*Circle No.* **7** *on Reply Card*

### Refractory Insulates Propane Butane Storage Tanks

. . . against fire above ground. The material, "K-20 Concrete Mix", was previously used with success in industrial heating furnaces subjected to 2000° F. temperatures. K-20 is a lightweight insulating concrete consisting of a kaolin base and a hydraulic setting cement binder. It is applied with a cement gun to a thickness of 1½-in. on the outside of the tanks, and is supported by steel car banding straps fastened against the tank casing by band tighteners. To these straps are fastened bent clips which, in turn, anchor the mix and serve as a spacer for a 2-in. galvanized steel wire mesh reinforcement. Before application of K-20, the tank shell is covered with a corrosion resistant paint. Because of the refrigeration effect produced in some types of tanks by the conversion of liquid to gas when the tank is being discharged, it is possible for water vapor in the atmosphere to condense on the outer surface of the tank. If the tank is insulated, water and ice may form under insulation and cause oxidation of the shell. The corrosion resistant paint prevents such a development. Test panels made of steel plates encased in K-20 were subjected in a furnace to a temperature of 1800° F. for a period of two hours. During this time the temperature of the steel underneath the insulation did not exceed 400° F; 800° F. is said to be the safe limit for the shell of an LP gas tank under emergency fire exposure. Babcock & Wilcox Co., 161 E. 42nd St., New York 17, N. Y.

*Circle No.* **8** *on Reply Card*



### Corrosion-Resistant Polyvinyl Chloride Fittings Available

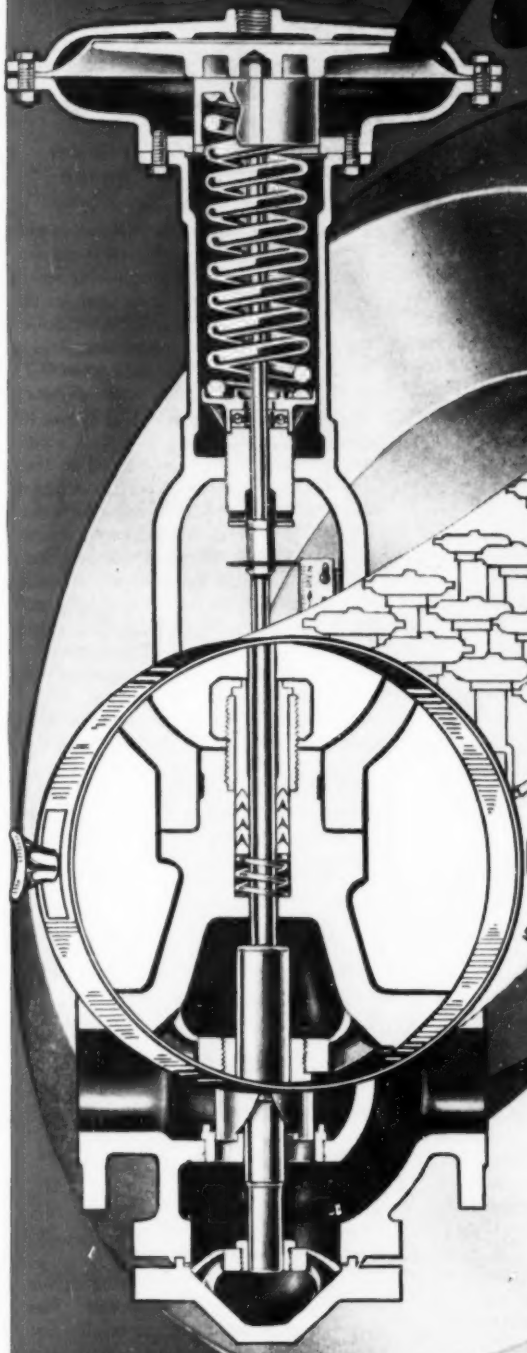
. . . for use with the manufacturer's pipes and valves of the same material, making possible a continuous system for use in solving corrosion problems. "Boltaron 6200" reducing bushings, plugs, unions and caps have been added to the earlier line, and are available in standard I.P.S. sizes. Boltaron, an unplasticized polyvinyl chloride, may be obtained in 30-in. x 60-in. sheets in 1/32-in. to 1-in. thickness, and in 10-ft. rods in ¼-in. to 2-in. thicknesses, as well as pipes, valves and fittings. H. N. Hartwell & Son, Inc., Boston, Mass.

*Circle No.* **9** *on Reply Card*

FISHER®

Teflon

V-RING PACKING



. . . LEADING THE MARCH TO BETTER DIAPHRAGM MOTOR VALVE PERFORMANCE

roved by many months of field service Fisher Teflon V-Ring Packing features:

- *No gland leakage.*
- *Used on wide range of pressures without appreciable change in friction va[illegible].*
- *Elimination of maintenance and adjustment.*
- *No valve stem lubricators required.*
- *Chemically inert to all fluids up to 450° F.*

Fisher Teflon V-Ring Packing is now standard equipment on all Fisher Diaphragm Motor Valves.

Bulletin E-200 gives complete details.

*Teflon is the trade name of E. I. Du Pont de Nemours & Co.

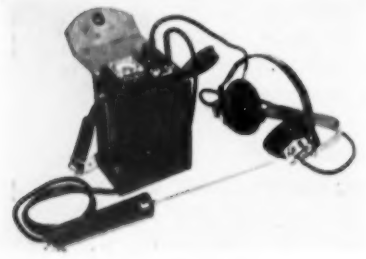
FISHER GOVERNOR COMPANY

MARSHALLTOWN, IOWA

### Versatile Mounting and Greater Compactness Features Motors

. . . following new frame size standards adopted by the National Electric Manufacturers' Ass'n. Announcement of a new line of electric motors in sizes from 1 to 40 hp. at 3600 rpm. by Louis Allis Co. came simultaneously with the NEMA changes. The new motors will become available in January. In the redesign, the maker has not only adjusted to the new standards but has taken full advantage of gains made in metallurgy, insulation, and design since the last change in NEMA standards some 25 years ago. The company based its new motor design on a comprehensive poll of its users. Changes have been made in bearings, ventilation, conduit box arrangement, and drip-proofing. However, no plans have been made for any price increase for the new, so-called "L.A." line. During the changeover period to the new line, the company will operate a dual production so that motors under the old standard can be supplied for replacement purposes. Louis Allis Co., Milwaukee, Wisc.

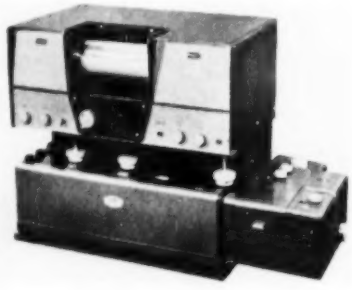
*Circle No.* **10** *on Reply Card*



### Electronic Detector "Sees" and "Hears" Equipment Troubles

. . . by locating the noise sources. The "Elec-Detec" Model V includes a milliammeter for checking sound impulses visually in addition to standard headphones for audible operation. The operator can locate trouble spots in such mechanical equipment as bearings, pistons, gears, and other moving parts. It is recommended as a preventive maintenance tool. Accuracy of the visual portion of the unit is claimed by use of a stable germanium crystal diode in the circuit. This crystal serves to rectify the current to record the electrical impulses accurately on the d.c. milliammeter, and to provide the wide frequency response required, it is said. Basically, the instrument is an audio device, consisting of a metal probe serving as a microphone, an amplifier, and a selector housed in a carrying case, and a set of headphones. Sensitivity is such that sounds normally heard only at high operating speeds can be picked up at low speeds, or even when the machine is turned by hand. Anco Instrument Div., American Name Plate & Mfg. Co., 4254 West Arthington St., Chicago 24, Ill.

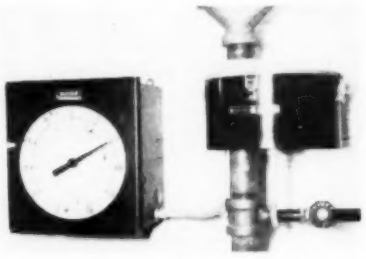
*Circle No.* **11** *on Reply Card*



### 'Robot' Spectrophotometer Runs Analyses Virtually Unattended

. . . and with accuracies matching or exceeding the best manual operation. The new fast, routine instrument has been built around the single-beam, quartz monochromator of the Beckman DU Spectrophotometer. The new Model DR automatically measures and records %-transmittance in the 210 to 1000 mu region of the spectrum, with as many as three samples running simultaneously and each curve being plotted in a different color. It takes 8 seconds to record a point for one sample. 10 for two and 12 for all three. Spectrograms are made on standard notebook-size graph paper. Once the controls are set, the device can run by itself for an entire day. The operator need only change samples, chart paper, and scanning regions. Beckman Instruments, Inc., So. Pasadena 1, Calif.

*Circle No.* **12** *on Reply Card*



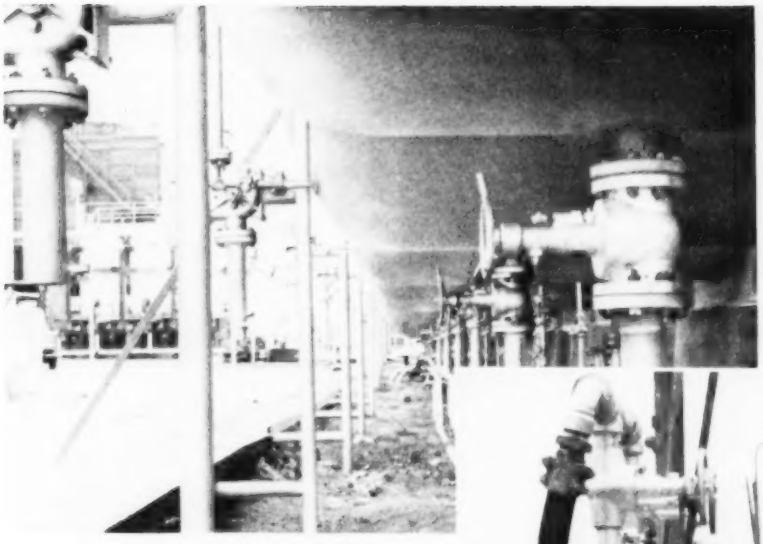
### Electronic Turbidity Recorder Has Accuracy in 5% Range

. . . and a precision of ±3% of full scale. Useful in process operations where water turbidity is an important factor, or for monitoring waste waters against stream pollution, or detection of oil contamination in boiler feeds, etc.; the new instrument has a range adjustable in the field from 0-25 to 0-10,000 ppm (silica scale). Theory of operation is that if a liquid has no suspended particles, all light is transmitted while none is scattered so that the ratio of scattered to transmitted light is zero. As turbidity increases more light is scattered, less transmitted, and the ratio increases. Detecting element is a single photovoltaic cell with current output proportional to the amount of light falling upon it. The light ratio is determined by computing the voltage output of the cell when scattered and then transmitted light are successively incident upon it. This is done by balancing the scattered light voltage against a battery, and at a later time balancing this remembered battery voltage against the transmitted light voltage. A range setting iris sets the photo cell illumination in the transmitted light beam equal to the photo cell illumination from the scattered light at any given point on the recorder scale where maximum accuracy is desired. This point of maximum accuracy may be 35, 70, or 100% of full scale. Power requirement of the sampling head is 175 watts, 115 volts AC; and of the recorder, 55 watts. Cycle time is 60 secs. General Electric Co., Special Products Section, Schenectady 5, N. Y.

*Circle No.* **13** *on Reply Card*

### Pump's Entire Liquid End Assembly Is Submerged

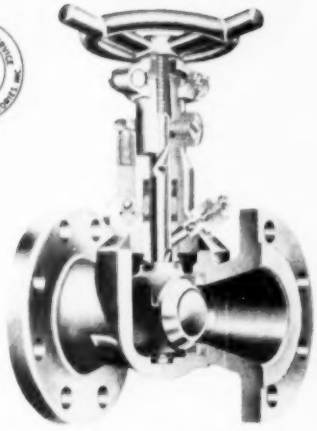
. . . in a sump with only the driver and discharge piping exposed. The new pump is designed especially for handling dangerous fluids. With the pumping cylinder submerged, problems of stuffing box leakage are eliminated. The unit is a variation of the manufacturer's "miniPump", and op-



ORBIT VALVES ®

# For SAFER Handling of LP-Gas from Plant to Loading Rack

***Void areas are eliminated in the body of Orbit Valves . . .***



A cross section view is furnished to show this important feature. When the valve is closed it drains clean to either side of the line. Orbit's Friction Free Seating principle gives a positive shut-off on both the down stream and up stream end of the valve. A simplified but rigid control mechanism makes this possible. The seat is vapor tight when closed.

The body is vapor tight too because both body and bonnet are made of dropped forged steel — the bonnet is welded to the body to form an integral unit.

Orbit Forged Steel LP-Gas Valves are rising stem type with adjustable plastic stem packing. Full Round opening type in sizes 1" to 4" Flanged or Screw end. Venturi Type in sizes 1" to 6" Flanged End only. ASA Class. Maximum rated working temperature 250 Degrees Fahrenheit.

***For Fast Regional Service call ORBIT'S Offices located in —***

| | |
|---|---|
| **HOUSTON, TEXAS** | 407 Velasco (Serving the Gulf Coast) |
| **ODESSA, TEXAS** | 402 West County Road (Serving West Texas) |
| **CASPER, WYOMING** | 1740 E. Yellowstone (Serving the Rocky Mountain States and Canada) |

**ORBIT VALVE COMPANY**

**P. O. BOX 699** **TULSA, OKLA.**

NOW

Roll tubes into thick tube sheets automatically! . . . from the inside out! with the

NEW AIRETOOL RETRACTIVE EXPANSION SYSTEM

With this new Retractive Method of Tube Expansion, the expander is fully inserted and rolls a short section of the tube. When full expansion is reached, it then automatically starts to retract. Keeps rolling as it retracts, gives full expansion to the tube the entire thickness of the sheet.

Advantages? *just check them!*

- √ Draws tube metal toward mouth, eliminates inward elongation.
- √ Each joint rolled automatically to predetermined tightness.
- √ Eliminates slow, costly steprolling.
- √ Continuous process rolling shortens rolling time.
- √ Tube sheets protected against distortion, enlargement of holes.

*To learn more about this efficient new Retractive Method of expanding high pressure tubes—write for your copy of AIRETOOL Bulletin No. 54.*

AIRETOOL
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

*There's an AIRETOOL Tube Cleaner and Tube Expander for Every Type of Tubular Construction.*

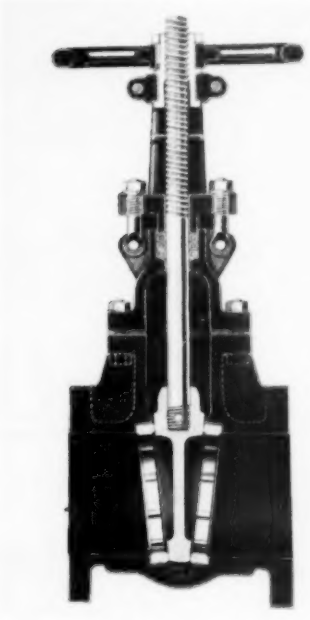
Branch offices: New York • Chicago • Philadelphia • Tulsa • Baton Rouge • Houston • Hudson Heights (NJ)

Representatives in principal cities of U.S.A., Canada, Mexico, South America, England.



erates in approximately the same range, with capacities up to 3200 milliliters/hr. and pressures up to 1000 psi. Milton Roy Co., 1300 E. Mermaid Lane, Philadelphia 18, Pa.

*Circle No.* **14** *on Reply Card*



### *Iron Gate Valve Designed For Mildly Corrosive Service*

. . . contains 3% nickel. Both body and bonnet are alloyed, while trim, where corrosion usually does greatest damage, is available in a choice of 18-8 Mo stainless steel or all-monel. This 125 lb. model is priced lower than the manufacturer's Causul metal valves, which are built to handle more severe corrosive conditions. Lunkenheimer Co., Box 360, Cincinnati 14, Ohio.

*Circle No.* **15** *on Reply Card*

### *Transparent Drawing Instrument Combines Engineering Tools*

. . . in one—triangles, T-square, straight edge, scales, protractor and parallel rules. "Glide-Rule" is pocket size, 2½-in. x 9-in., has engraved scales and protractor, four drawing edges with scales in 16th and 20ths. The protractor is a full 180° with emphasized 30°, 45° and 60° angles. Operation of the unit leaves one hand free for drawing. The instrument rolls both up and down and right and left. A small thumb button permits the user to change direction and roll the instrument quickly to the desired position. Smith Drake Corp., 1206 S. La Brea Ave., Inglewood, Calif.

*Circle No.* **16** *on Reply Card*

# INTALOX SADDLE PACKING DISTILLS 10% MORE CHARGE IN 10% LESS TIME

Field experience is consistently bearing out earlier test data reflecting the greater efficiency of Intalox Saddle Packing. But it is infrequent to have such excellent comparative data as that furnished us by a major manufacturer of organic chemicals.

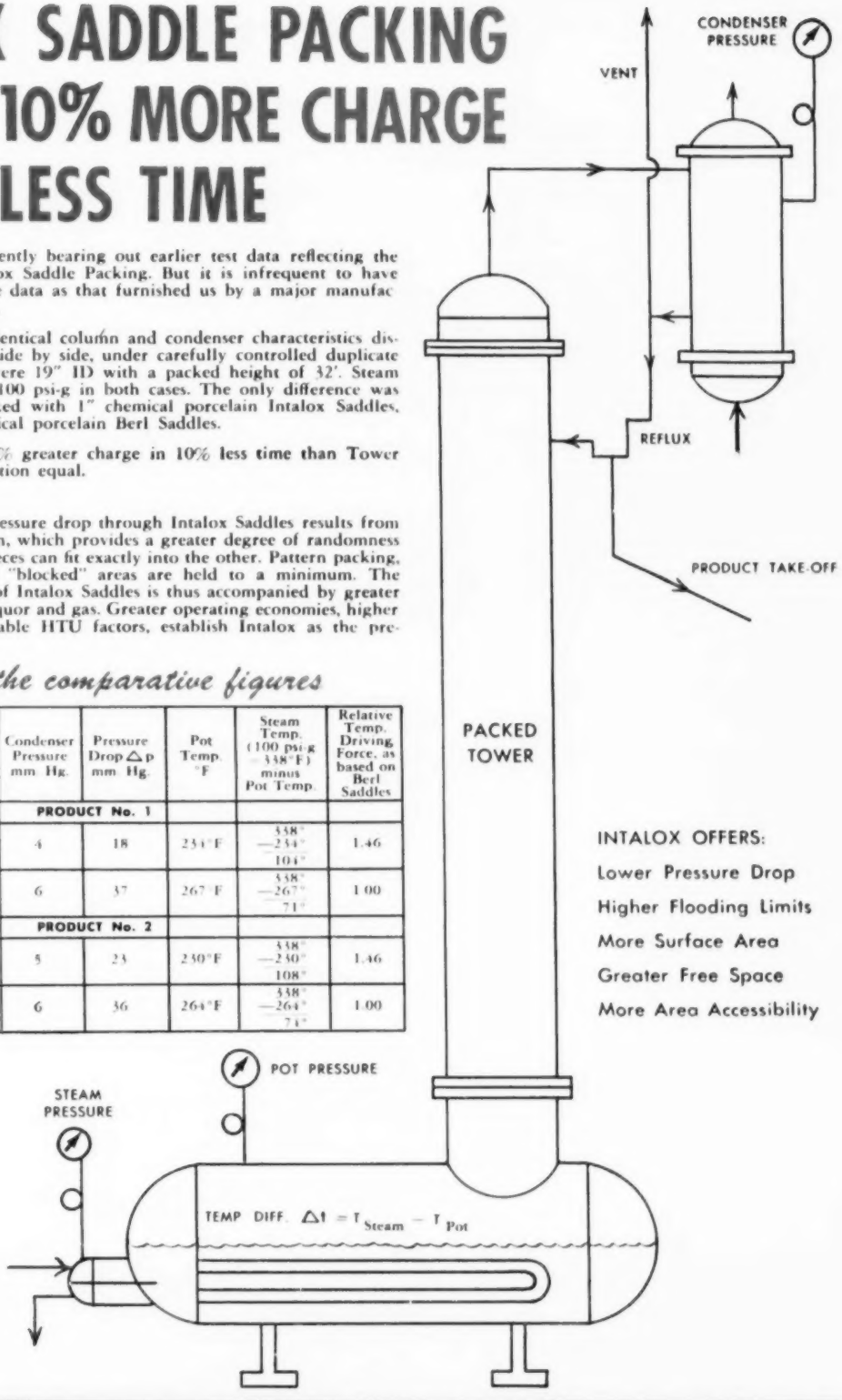
Two column stills with identical column and condenser characteristics distilled the same materials side by side, under carefully controlled duplicate conditions. The Towers were 19" ID with a packed height of 32'. Steam pressure in the coils was 100 psi-g in both cases. The only difference was that Tower "A" was packed with 1" chemical porcelain Intalox Saddles, Tower "B" with 1" chemical porcelain Berl Saddles.

Tower "A" handled a 10% greater charge in 10% less time than Tower "B" with product specification equal.

The substantially lower pressure drop through Intalox Saddles results from the unique, patented design, which provides a greater degree of randomness in packed beds. No two pieces can fit exactly into the other. Pattern packing, nesting, over-lapping and "blocked" areas are held to a minimum. The greater total surface area of Intalox Saddles is thus accompanied by greater available surface area to liquor and gas. Greater operating economies, higher product yields, and favorable HTU factors, establish Intalox as the preferred packing.

*Here are the comparative figures*

| Tower | Type of Packing | Pot Pressure mm. Hg. | Condenser Pressure mm. Hg. | Pressure Drop △p mm Hg. | Pot Temp. °F | Steam Temp. (100 psi-g = 338°F) minus Pot Temp. | Relative Temp. Driving Force, as based on Berl Saddles |
|---|---|---|---|---|---|---|---|
| | | | **PRODUCT No. 1** | | | | |
| A | 1" Intalox Saddles | 22 | 4 | 18 | 234°F | 338° —234° 104° | 1.46 |
| B | 1" Berl Saddles | 43 | 6 | 37 | 267°F | 338° —267° 71° | 1.00 |
| | | | **PRODUCT No. 2** | | | | |
| A | 1" Intalox Saddles | 28 | 5 | 23 | 230°F | 338° —230° 108° | 1.46 |
| B | 1" Berl Saddles | 42 | 6 | 36 | 264°F | 338° —264° 74° | 1.00 |




INTALOX OFFERS:

Lower Pressure Drop

Higher Flooding Limits

More Surface Area

Greater Free Space

More Area Accessibility

**U. S. STONEWARE**

**AKRON 9, OHIO**

## Where corrosion...temperature...pressure cause other valves to fail . . .

## THEY'RE "STICK-PROOF"

## Operate Instantly...Everytime...Anytime

For more than 20 years, in practically every type of industry, HOMESTEAD LEVER-SEALDS have been giving trouble-free performance in services where extremes of temperature or pressure or corrosive line fluids cause ordinary valves to "stick" or "seize."

HOMESTEAD Lever-Seald PLUG VALVES are "Stick-Proof" because they're "Lever-Seald," which means that a powerful lever-and-screw device, built into every valve, assures positive action at all times under all conditions.

They operate fast, too—full open or closed by a quarter-turn; and because all operating parts are protected from line fluids, service conditions and weather, they last longer and cost less to maintain.

We make them in metals and alloys to suit your requirements in sizes 1½" to 12", for pressures from vacuum to 1500 lbs. and for temperatures ranging from 40° below zero to 1100° F.

**note these exclusive HOMESTEAD features**

- Instant Stick-Proof operation.
- Quarter-turn fully opens or closes.
- Positive seal without lubrication.
- Seating surfaces always protected in both open and closed positions. Corrosion practically eliminated.
- Unobstructed straight-line fluid flow.
- All operating parts protected from damaging effects of service conditions and weather.

For Complete details and prices, write today for your copy of VALVE REFERENCE BOOK No. 39-3. No obligation.

**HOMESTEAD VALVE MANUFACTURING COMPANY**

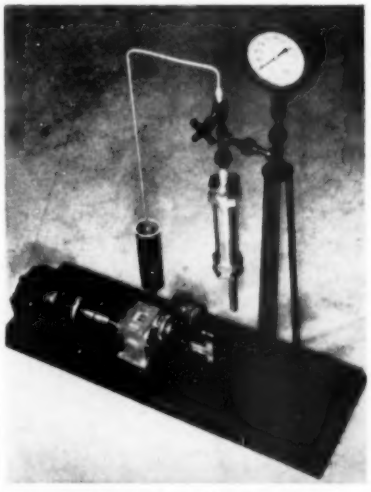
*"Serving Since 1892"*

P. O. Box 43 Coraopolis, Pa.

### *Needle Control Valves Have "O" Ring Seal*

. . . or conventional packing. "270 Series" valves are made of brass or 430F stainless steel bar stock in sizes from ⅛-in. to ½-in. Both straight line and angle patterns can be obtained. The "O" ring style is said to be particularly suitable for test panel high pressure air or hydraulic service, no packing adjustment being required. If helium-leak tested, "O" ring style may be used for high-vacuum service. The valves have a self-aligning spindle which is said to insure tight seating. Units are available for direct instrument mounting, with black plastic handwheel. Hoke, Inc., 161 S. Dean St., Englewood, N. J.

*Circle No.* **17** *on Reply Card*



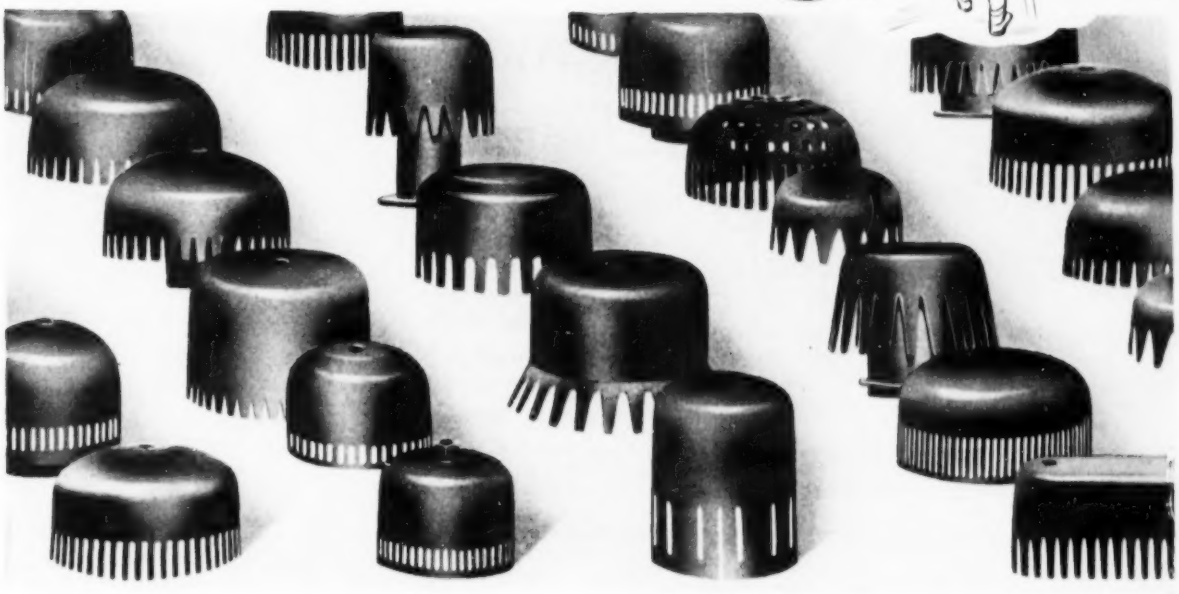
### *Grease Pressure Viscometer Meets ASTM D-1092 Specs*

. . . and is suitable for tests and research on viscosity of greases under varying shear rates and temperatures. Units contain a ¼ hp. motor, 200:1 speed reducer, a pump and heavy duty pipe connections. Four pressure gages of 0—50, 0—100, 0—500, 0—2000

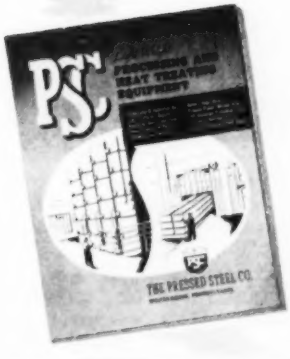
# You'll Be Days and Dollars Ahead

WITH

# PSC BUBBLE CAPS



## 300 Standard Styles of Caps & Risers *Promptly* Furnished *Without Die Cost*




With dies on hand for 300 styles of bubble caps and risers, The Pressed Steel Co. saves many customers not only the cost of dies but also design and delivery time. Check PSC and you can be days and dollars ahead.

Another advantage PSC customers enjoy: -- we fabricate from the complete list of alloys. Thus we are able to use the one particular alloy which best meets your coking and corrosion conditions.

Special caps to your order. Cap, riser and assembly details can be modified in an unlimited number of ways to suit your needs. Furnished for all methods of tray assembly. Complete engineering details on all 300 styles in Catalog 52.

**Send for Process Equip. CATALOG 52**

## THE PRESSED STEEL COMPANY

of WILKES-BARRE, PENNSYLVANIA

*Industrial Equipment of Heat and Corrosion Resistant* WEIGHT-SAVING *Sheet Alloys*

☆ ☆ ☆ OFFICES IN PRINCIPAL CITIES ☆ ☆ ☆

For Eye-Level Readings...

AUTO-LITE

...TEMPERATURE INDICATION

3-way adjustable mounting

Auto-Lite offers many thermometer styles, permitting plant-wide temperature observation at low cost. Standard temperature ranges from minus 60°F to plus 750°F. Send for latest catalog showing various types.

**Model F-1 temperature indicator**—Rigid stem or capillary tubing for EYE-LEVEL remote reading. Priced from $22.

THE ELECTRIC AUTO-LITE COMPANY
INSTRUMENT AND GAUGE DIVISION
TOLEDO 1, OHIO
NEW YORK • CHICAGO • SARNIA, ONTARIO

TEMPERATURE INDICATORS & RECORDERS

For Temperature Control

# $35 Nicholson Trap Replaces $200 Unit

Again demonstrating their remarkable effectiveness as a low-cost temperature control, a large processor reports Nicholson expansion steam traps, at about $35 each, are being installed on outdoor tanks and stills in place of temperature controls. These were costing $110.00 to $200.00, with cost of trap added.

The Nicholson traps are readily adjusted to pass condensate at any temperature below 212°F. No air binding. Lengths, 9" to 40". Easily installed, usually without supports. Pressure, 0 to 250 lbs.

For All Equipment Using Steam or Hot Water

| | | |
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| Dryers | Kettles | Retorts |
| Evaporators | Paper Machinery | Separators |
| Heat Exchangers | Pipe Coils | Steam Stills |
| Heaters | Radiators | Storage Tanks |

CATALOG 953

215 Oregon St., Wilkes-Barre, Pa.

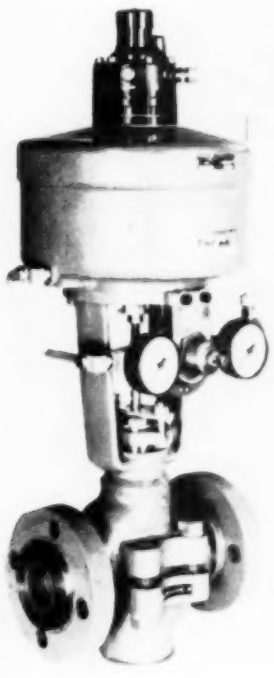
W. H. NICHOLSON & CO.

TRAPS · VALVES · FLOATS



psi. ranges come with the apparatus, and each is fitted with a pressure union for quick attachment. Three grease chambers and eight capillaries comprise the viscometer and are said to be machined to better than ASTM requirements. Technical Equipment Co., 743 Dwight Way, Berkeley 10, Calif.

*Circle No.* **18** *on Reply Card*



### *Valve Positioning Device Permits Pressures*

. . . to be in either the upper or lower cylinder chamber. "LB Series" pneumatic control valves combine a new concept of valve topworks design with a single seated, split body valve. The topwork consists of an aluminum cylinder with bored and honed integrals, a plastic piston with graphite impregnated "O" ring seal, and a positioner which allows static or cushion loading pressures in either chamber. It is said an operator can position accurately to well over one part in 1000 of instrument output span. The new series is obtainable in sizes up to and including 4 in., and for Series 15, 30, and 60 body ratings. Valve bodies are standard in carbon steel, bronze, aluminum, 316 stainless steel, Hastelloy and Durimet plus a number of semi-standard alloys. Trim materials include alloys, hardened stainless steel,

***when you buy***

# CHEMICAL DESALTING

***be sure you get***

**The Tretolite Company pioneered chemical desalting. Because of our long manufacturing experience, we believe we make the best desalting chemicals available. However, as good as Tretolite desalting chemicals are, they are at their best only when they are correctly applied.**

The Tretolite Company sells no desalting equipment. Our interest in your desalting plant design is based only on one desire: to make sure your desalting plant is set up so you get maximum desalting performance from the chemical used. We believe we sell the best desalting chemicals available—we know we give the best service. Just give us a chance on your next desalting installation.

*To assure maximum desalting efficiency, the Tretolite Company provides a complete service department, staffed by experienced desalting engineers. When you specify Tretolite desalting, you are assured of*

1. **Preliminary performance-prediction tests**
2. **Plant design consultation, design advice, drawings**
3. **Supervision and consultation during construction**
4. **Assistance and cooperation for the "start-up"**
5. **Instruction for refinery personnel**
6. **Continuing service calls and inspections**

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A DIVISION OF THE PETROLITE CORPORATION

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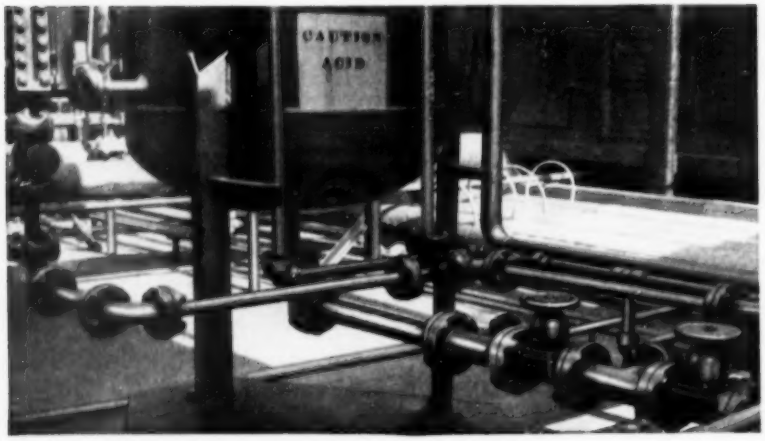
*Chemicals and services for the petroleum industry*

DESALTING • DEHYDRATING • CORROSION INHIBITING
SCALE PREVENTING • WATER DE-OILING • PARAFFIN REMOVING

ED-53-1

# CORROSIVE FERRIC CHLORIDE FLOWS THROUGH THIS SARAN LINED INSTALLATION

## Large West Coast refinery depends on easy-to-install SARAN LINED STEEL PIPE to resist corrosion and assure uninterrupted processing




Some time ago, a large West Coast oil company investigated better methods to handle corrosive ferric chloride solution. The company's successful operation demands uninterrupted processing. Unscheduled "shut-downs" mean production pile-ups, lay-offs and heavy expense. Saran Lined Steel Pipe was successful from the start. The use of Saran Lined Pipe Fittings and Valves assured tight, leak-proof joints. The dependable, long-term service and excellent corrosion resistance of strong, rigid Saran Lined Pipe will postpone replacements indefinitely. Saran Lined Steel Pipe can be delivered immediately, cut and threaded to your specifications or fabricated in the field with your own equipment. We'll be glad to assist you with installation plans. Write or call the SARAN LINED PIPE COMPANY, Ferndale, Michigan. Offices in New York • Boston • Pittsburgh • Tulsa Philadelphia • Chicago • Portland Indianapolis • San Francisco • Houston Denver • Los Angeles • Seattle Cleveland • Charleston, S. C. Toronto • Montreal.

Saran Lined Pipe Company
2415 Burdette Ave., Ferndale, Mich.

Please send me a copy of your catalog on Saran Lined Pipe, Valves and Fittings.

Name _____

Title _____

Company _____

Address _____

City _____ State _____

RELATED SARAN PRODUCTS

Saran rubber tank lining • Saran rubber molding stock • Saran pipe and fittings • Saran tubing and fittings

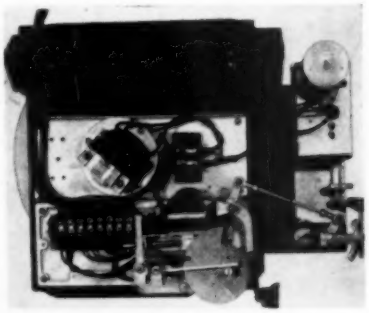
**SARAN LINED PIPE COMPANY**

2415 BURDETTE AVENUE, FERNDALE, MICHIGAN




hard-faced metals and non-metallic seating surfaces. Angle type bodies are available. Conoflow Corp., 2100 Arch St., Philadelphia 3, Pa.

*Circle No.* **19** *on Reply Card*



### *Electronic Flow Meter Uses Mercury-Less Transmitters*

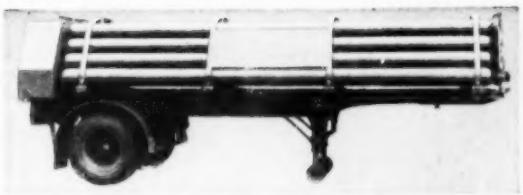
. . . of the metallic bellows, rupture-proof type. The meter is available in several different models for indicating, recording and with a continuous type mechanical integrator for measurement of flow of fluids and gases. Differential pressure transmitters used are for differentials of from 20 in. water to 750 in. water with a standard static operating pressure of 150 psig, with higher pressure ratings obtainable if desired. Meter can also measure liquid level in an enclosed vessel such as a boiler drum. Transmitter for this application differs from the others in that it is a buoyant float operated type with torque tube assembly. Transmission system employed between transmitter and recorder makes use of differential transformers and a null balance AC system independent of line voltage variations. An electronic amplifier in the meter circuit is said to give maximum sensitivity and high speed of response. The unit is said to unaffected by normal voltage, frequency, temperature variations or reasonable length of transmission lines. It has a 3 to 1 range calibration at the recorder, 12 in. uniformly graduated charts and no integrator creep at zero. Indicators can be calibrated to read directly. Hays Corp., Michigan City, Ind.

*Circle No.* **20** *on Reply Card*

### *New Fabrication Procedure In Jacketed Piping System*

. . . eliminates need for steam or coolant jumpers and flanged joints, except where piping must be disassembled. The jacketed fitting combination consists of long and short radius

# NEW hydrogen transport solves refiners' storage problems



Semi-trailer with 30 or 38 tubes is delivered to point of usage. Capacity of 30 tube unit is 39,000 cu. ft. at 2400 psi; of 38 tube unit, 50,000 cu. ft. at 2400 psi.

Taylor-Wharton can also furnish individual storage cylinders, made to ICC 3A2400 classification and qualifying under API-ASME for 1450 psi.

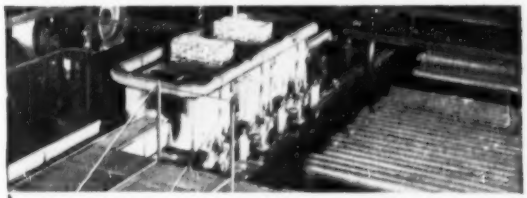
**Semi-trailer Mounts 30 or 38 Tubes for Mobile, Compact, High Pressure Hydrogen Storage**

In response to hydrogen storage problems faced by new platforming process plants, Taylor-Wharton offers two kinds of high pressure cylinder installations, the permanent and the transport, now successfully used in the chemical industry.

Investigation of high pressure equipment will reveal the economy of this method of storage. (Low pressure storage requires an expensive compressor.) The tubes readily provide a flexible supply of hydrogen to get you "on stream" quickly. High pressure storage saves space, packing up to 50,000 cubic feet of hydrogen at 2400 psi in the transport.

Write now for Bulletin 300 which will show you the economy of Taylor-Wharton cylinders for your hydrogen plant.

Taylor-Wharton high pressure transports efficiently store and deliver for Allied Chemical & Dye Corporation. High storage capacity and mobility will save handling dollars and floor storage space for you too.



Modern heat treating facilities for tubes at Taylor-Wharton Iron and Steel Company.

ESTABLISHED TW IN 1742

## TAYLOR-WHARTON IRON & STEEL COMPANY

CINCINNATI 12, OHIO

**Also Manufacturers of: Manganese Steel Castings, Alloy and Carbon Steel Castings, Special Trackwork, Gas Cylinders**

SAFETY FEATURE ADDED TO
Ohio's Type 1000
RETURN BEND

BAR-TYPE PLUG PULLER PROTECTS the MAINTENANCE MAN

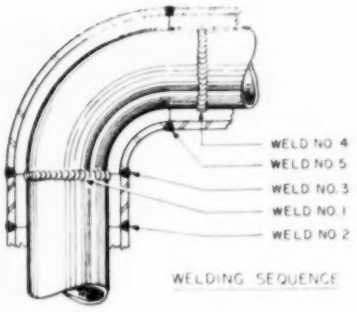
- One-man operation
- No loose pieces
- Holds plug in place after seal is broken
- Cannot damage return-bend seat or plug
- Full leverage on closest centers
- Pullers available for all sizes (separate puller required for each size)

THE OHIO STEEL FOUNDRY CO.
LIMA, OHIO—Plants at Lima and Springfield, Ohio

District offices in:
Chicago, Cincinnati, Cleveland, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, St. Louis, Tulsa

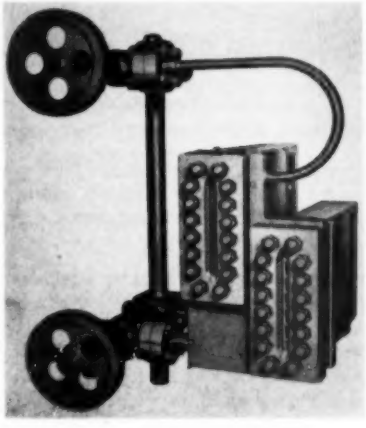


90° "Tube-Turn" elbows, with their center line radii closely matching. On one end of the inside elbow is a tangent that extends beyond the corresponding end of the outside elbow.




On the other end of the inside elbow a short piece of pipe is attached to facilitate the installation work. The welding sequence illustrated above must be followed exactly. Among the features cited by the manufacturer for this new method of fabricating jacketed fittings are more accurate temperature control, minimization of thermal expansion and contraction problems, optimum flow conditions, and sharp reduction in maintenance costs. Tube Turns, Inc., 224 E. Broadway, Louisville 1, Ky.

*Circle No.* **21** *on Reply Card*



### *Boiler Gage Glass Divided Into Short Sections*

. . . to reduce breakage. Instead of using a long slender piece of glass with attendant high stresses, the manufacturer has divided the glass into a series of short sections, mounted with thin

# 3000 impulses help keep mid-west refinery "on stream"

THIS big refinery at Lawrenceville, Ill.—like a lot of other important refineries — uses Yarway Impulse Steam Traps.

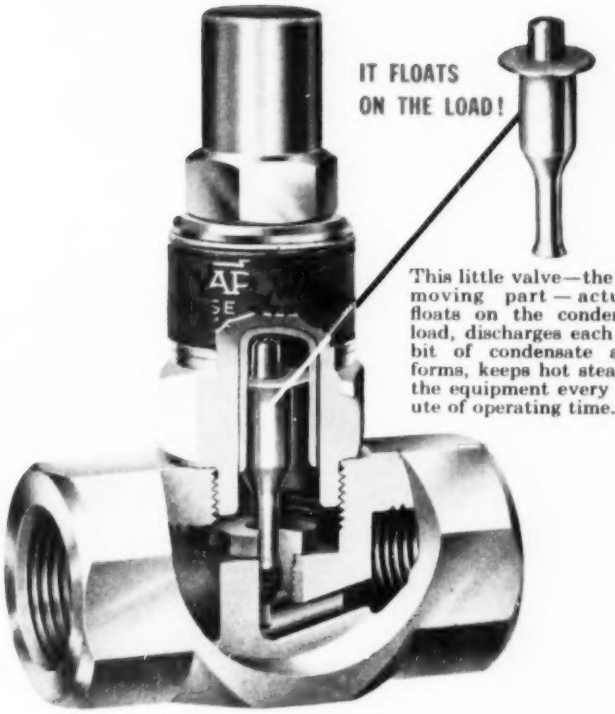
Over 3000 Yarway Impulse Traps are installed on tracer lines and for draining steam headers.

Popular features of the Yarway Impulse Steam Trap are its ability to get equipment *hot in a hurry*—and keep it hot! . . . also its small, handy size—fits in easily in any location; its stainless steel body and working parts; quick installation; easy maintenance; low initial cost.

Another advantage—IMMEDIATE DELIVERY from 250 local distributors, plus quick service from nearby Yarway field engineers.

More than 900,000 Yarway Impulse Steam Traps have been sold. For a free Steam Trap Selector, write . . .

**YARNALL-WARING COMPANY**
153 Mermaid Ave., Philadelphia 18, Pa.




This little valve—the only moving part—actually floats on the condensate load, discharges each tiny bit of condensate as it forms, keeps hot steam in the equipment every minute of operating time.

YARWAY® impulse® steam trap

 (To obtain more data on advertised products see page 1760) 

mica separators in the joints. The company is furnishing this sectional gage glass on all its Bi-Color Gages operating at pressures in excess of 1350 psi. Diamond Power Specialty Corp., Lancaster, Ohio.

*Circle No.* **22** *on Reply Card*

## Trade Literature

### Ammonia Absorption

. . . in beds of saddles; a reprint of a master's degree thesis at West Virginia University by Chin-Yung Wen; includes literature survey, experimental data, correlation and analysis and conclusions, with a bibliography. West Virginia University, Morgantown, W. Va.

*Circle No.* **23** *on Reply Card*

### Industrial Chemicals

. . . catalog, offered by the company to help celebrate its 75th birthday; a listing of all the products now made by the manufacturer, and what industries, in general, are using them; in 104-page catalog. Consolidated Chemical Industries, Inc., 630 Fifth Ave., New York 17, N. Y.

*Circle No.* **24** *on Reply Card*

### Automatic Unit Regulator

. . . for flow, pressure, proportioning and other variables; 8-page *Bulletin* 155 describes operating principles and different models of these self-contained hydraulic control mechanisms. Askania Regulator Co., 240 E. Ontario St., Chicago 11, Ill.

*Circle No.* **25** *on Reply Card*

### Control of Waste Discharge

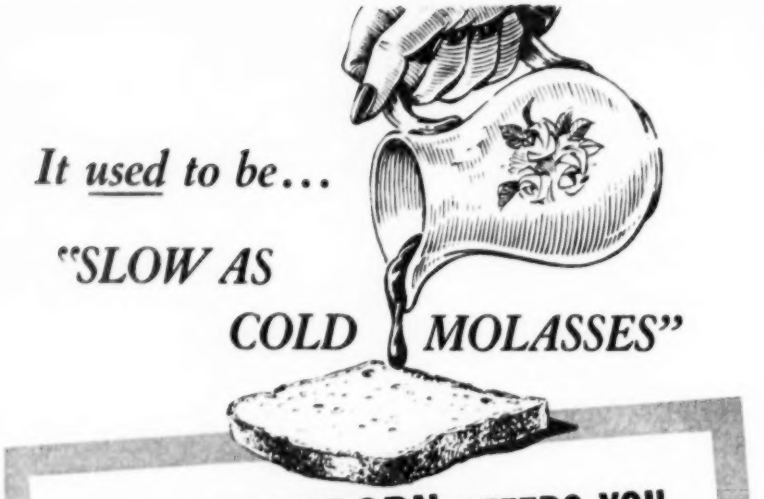
. . . into state and municipal sewer systems; *Application Memo* 600-K2 contains a flow diagram showing the method and explains the uses of the Model RCB controlling instruments. B-I-F Industries, Inc., Providence 1, R. I.

*Circle No.* **26** *on Reply Card*

### Liquid Level

. . . of the continuous measurement type; 4-page *Bulletin L*-1053 briefly lists the features and specifications of the manufacturer's instrument, with some line drawings of typical installations. Instruments, Inc., 122 N. Madison, Tulsa 6, Okla.

*Circle No.* **27** *on Reply Card*


NOW SONNEBORN OFFERS YOU
*free-flowing*
PETROLEUM SULFONATES

SONNEBORN'S new ISO-PETRONATES are free flowing at room temperature. Now, for the first time, 62% concentrates can be used where steam is not available or where heating is difficult, assuring easier handling, suggesting new applications.

ISO-PETRONATES are but one example of the ability of SONNEBORN to adapt Petroleum Sulfonates to meet specialized requirements.

Where you require emulsification and dispersion of liquids... dispersion and wetting of solids...wetting and dispersion of liquid-solid systems...inhibition of rust and corrosion...one of the SONNEBORN oil soluble or water soluble Petroleum Sulfonates could be your answer.

**THE COUPON BELOW MAY BRING THE ANSWER TO YOUR PROBLEM. CLIP AND MAIL IT TODAY!**

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☐ We need specific information. Please have your representative call.

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CITY_____ ZONE_____ STATE_____

# All SHELL AND TUBE ...HEAT EXCHANGERS by Vogt

## At LOUISVILLE REFINING CO.'S New CATALYTIC CRACKING PLANT

*ABOVE: View of new construction at Louisville Refining Company.*

*BELOW: Some of the many Shell and Tube Exchangers.*

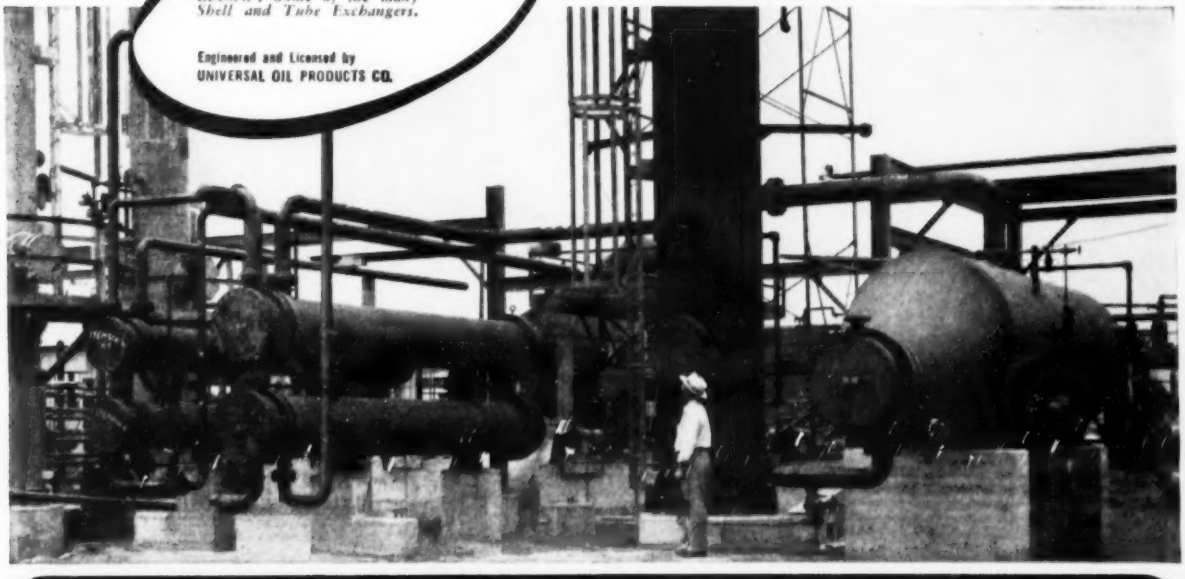
Engineered and Licensed by
UNIVERSAL OIL PRODUCTS CO.

Premium gasoline production has been boosted 20% from the same amount of oil charged since the Louisville Refining Company's new Catalytic Cracking Plant went on stream.

The new plant uses Vogt Shell and Tube Heat Exchangers exclusively and they make a significant contribution to the efficient and economic operations of this progressively modern refinery.

Vogt Shell and Tube Heat Exchangers are available in many different types, with fixed or removable tube bundles, to meet the special problem and specific operating conditions of each installation. They are constructed from carbon and special steels to meet every temperature, pressure, or vacuum service requirement.

*WRITE FOR BULLETIN HE-6*



**HENRY VOGT MACHINE CO.** Louisville 10, Ky. • BRANCH OFFICES: NEW YORK, PHILADELPHIA, CHICAGO, CLEVELAND, ST. LOUIS, DALLAS, CHARLESTON, W. VA.

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We need a technically-trained man, under 30, for the editorial staff of PETROLEUM PROCESSING. He should have a background of mechanical engineering and experience in refining or petrochemical manufacturing operations—with emphasis on equipment. He should be able to write clearly and cleanly, and have done some work in preparing reports.

He should have an inquisitive mind and like to probe into the "why" of things, and be able to explain to others what he has found out.

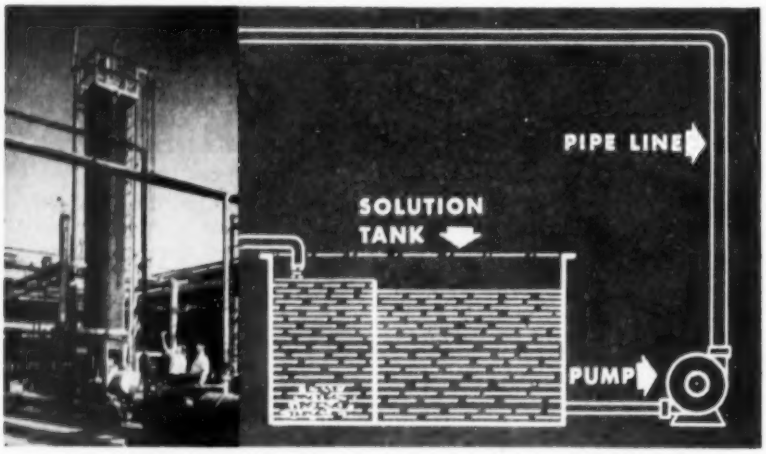
Experience in magazine or newspaper production is desirable but not essential.

Duties will include editing and rewriting copy, with responsibility for specific departments in the magazine, and field trips to gather data for original articles. Location is in New York City, and salary is open. Send details to:

**EDITOR, PETROLEUM PROCESSING**

**1213 West Third Street • Cleveland 13, Ohio**






# Tower cleaning cost cut by $1000

**Here's the blueprint of a chemical cleaning installation that saves one refiner $1000 on his tower maintenance.**

**Material? Recommended Oakite detergent solution for speedy, thorough removal of grease, waxes, entrained crude—iron sulfides, chlorides, oxides.**

**Method? *In-place* circulation of solution. No dismantling, reaming or sawing. Cuts *days* off cleaning time.**

**Results? Men who use it say: "Never spent 80 bucks so happily to save $1000." "Increased output 400 gallons per hour." "Good results —even trays near top come out clean."**

**Details? Absolutely *free,* including blueprints. Write Oakite Products, Inc., 37 Rector St., New York 6, N. Y.**

*Technical Service Representatives in Principal Cities of U. S. & Canada*

SPECIALIZED INDUSTRIAL CLEANING

**OAKITE**

MATERIALS • METHODS • SERVICE

**PETROLEUM SERVICE DIVISION**


## What's New!

### Mobile Laboratory

. . . for use in a wide variety of field testing applications; the manufacturer's story on what this unit is equipped to do, where it will go, and the different equipment it can carry; in a 12-page brochure. Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.

*Circle No.* **28** *on Reply Card*

### Nuclear Instruments

. . . for a wide variety of purposes; 38-page *Catalog M* lists detectors, area monitors, counting systems, scaling units, shields and mounts, timers, etc., giving specifications and a brief description of each item. Nuclear Instrument & Chemical Corp., 223 W. Erie St., Chicago 10, Ill.

*Circle No.* **29** *on Reply Card*

### Liquid Level Gaging

. . . equipment; 18-page *Bulletin CP-3003* features operational data on manufacturer's new relay type selective receivers in 36, 48 and 60 tank capacity models with key-type selector switches rather than conventional dial selector. Vapor Recovery Systems Co., Compton, Calif.

*Circle No.* **30** *on Reply Card*

### Flow Control Valve

. . . designed to replace gate valves which require frequent manual opening and closing; 4-page *Bulletin W-8* offers design and construction features, along with a complete parts lists, dimensions and specifications. Golden-Anderson Valve Specialty Co., 2143 Keenan Bldg., Pittsburgh 22, Pa.

*Circle No.* **31** *on Reply Card*

### Tube and Pipe Fittings

. . . in 28-page *Catalog* 553, which describes and illustrates with cut-away drawings and photos the flare and no-flare types of tubing, as well as the company's complete line of pipe fittings; with engineering tables and full specifications. Flodar Corp., 1386 E. 45th St., Cleveland 3, Ohio.

*Circle No.* **32** *on Reply Card*

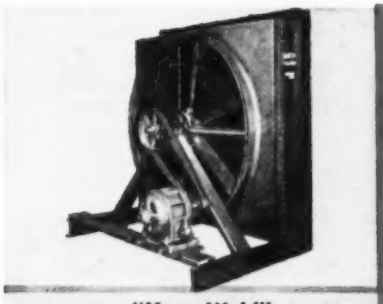
### Pyrometer Supplies

. . . illustrated and described in the manufacturer's newly-revised *Buyer's Guide* 100-5, which lists all general thermocouple assemblies and components and special purpose items; prices included. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa.

*Circle No.* **33** *on Reply Card*

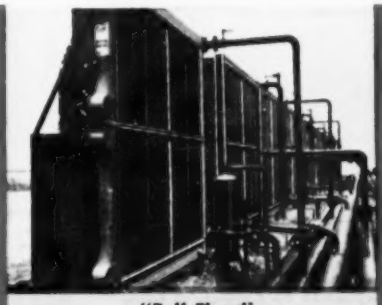
# Use Them Individually or in Combination...

## YOUNG HEAT TRANSFER PRODUCTS
## Are ALL Engineered to Work Together



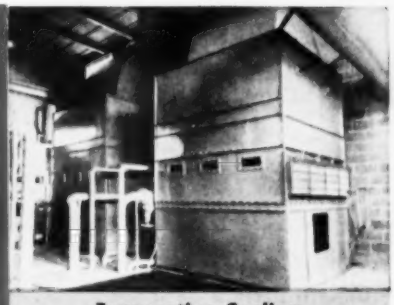
**"Mono-Weld" Jacket Water Coolers**

Rugged, welded-steel construction assures maximum strength with minimum weight for stationary or semi-portable equipment. Core sections readily replaceable. Tanks easily removed for cleaning.



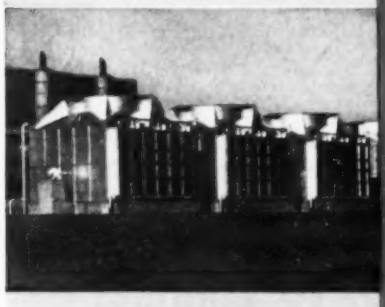
**"Full-Flow" Jacket Water Coolers**

Sturdy, welded-steel frame with specially-designed Young "Full-Flow" cast tanks. Flexible mountings absorb vibration, allow for expansion and contraction. Tanks easily removed for cleaning.



**Evaporative Cooling and Condensing Units**

Self-contained units in six basic models, with single or two-coil assemblies. Sectional design provides versatility, ease of handling. Used primarily for cooling Diesel engine jacket water and lube oil.

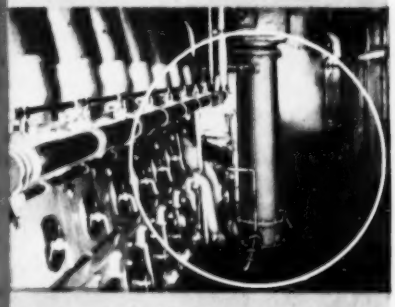


**"VAD" Cooling and Condensing Units**

Vertical air discharge permits compact multiple unit installations without loss of efficiency due to cross winds. Low-level mounting, low-cost installation, easy inspection and maintenance are features.

**"HC" Cooling and Condensing Units**

Horizontal core construction with vertical air discharge. Rugged structural design; wide choice of cores; complete with fans, power plants and controls. In single or multiple type units.



**Shell and Tube Heat Exchangers**

Available in 690 standard models, single to four-pass, fixed and removable tube bundles. Unusually close-tolerance construction assures maximum cooling with minimum weight. Calculator available.

**YOUNG RADIATOR COMPANY**

Dept. 263-L, Racine, Wisconsin
Plants at Racine, Wisconsin and Mattoon, Illinois

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Photographed just after the ASME-API inspection of its container, this FULFLO FILTER is one of three specifically engineered by Commercial Filters for wax de-hazing service at the new refinery of Cit-Con Oil Corp., Lake Charles, La. A feature article about these special filters appears elsewhere in this issue.

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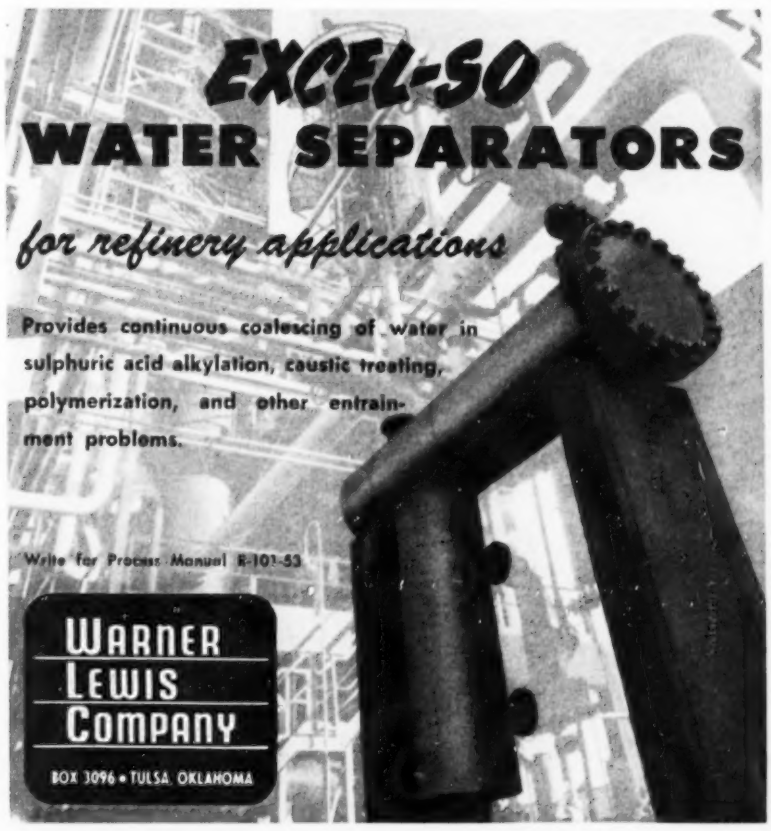
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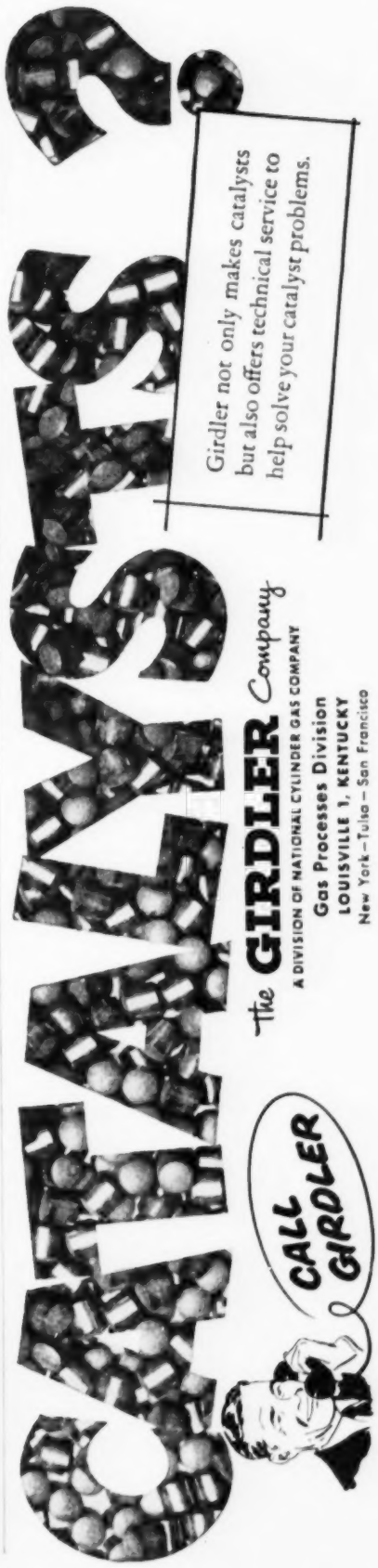
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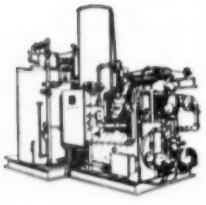

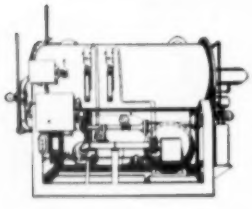

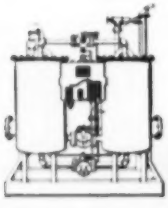

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## What's New!

### Quality Control

. . . a manufacturer's story on how his new non-destructive testing program is working out, what equipment and techniques are being used; in 6-page *Bulletin SK-2*. Schutte and Koerting Co., Cornwells Heights, Bucks County, Pa.

*Circle No.* **34** *on Reply Card*

### Refractories

. . . for heat and power; a 32-page booklet designed to help in selection of the proper refractories for specific performances; contains details and characteristics on all the manufacturer's products. Norton Co., Worcester 6, Mass.

*Circle No.* **35** *on Reply Card*

### Pallet Roller

. . . for shifting palletized loads quickly in any direction; Engineering *Bulletin 104* K illustrates construction details, gives dimensions, weight capacities. Frank L. Robinson Co., Latham Square Bldg., Oakland 12, Calif.

*Circle No.* **36** *on Reply Card*

### Oxygen Analyzer

. . . using the element as the direct source of measurement; manufacturer's equipment is explained, with photographs and line drawings helping the discussion, in 8-page *Folder-ND*46-91(3). Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.

*Circle No.* **37** *on Reply Card*

### Process Equipment

. . . design and construction details; 8-page *Bulletin* 250 has illustrations and descriptions of many of the company's processing items. Whitlock Mfg. Co., 48 South St., Elmwood, Hartford 10, Conn.

*Circle No.* **38** *on Reply Card*

### Oil-Immersed Starters

. . . ratings, dimension diagrams, design and maintenance features with 20 illustrations in 8-page *Bulletin GEA*-3541. General Electric, Schenectady 5, N.Y.

*Circle No.* **39** *on Reply Card*

### Infrared Analyzers

. . . with illustrations and discussion on principles of operation, performance, construction details, installation, etc.; in 18-page bulletin. Liston-Becker Co., 649 Hope St., Stamford, Conn.

*Circle No.* **40** *on Reply Card*

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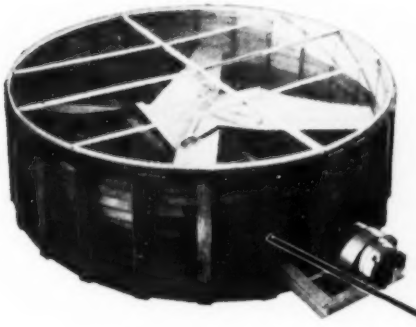

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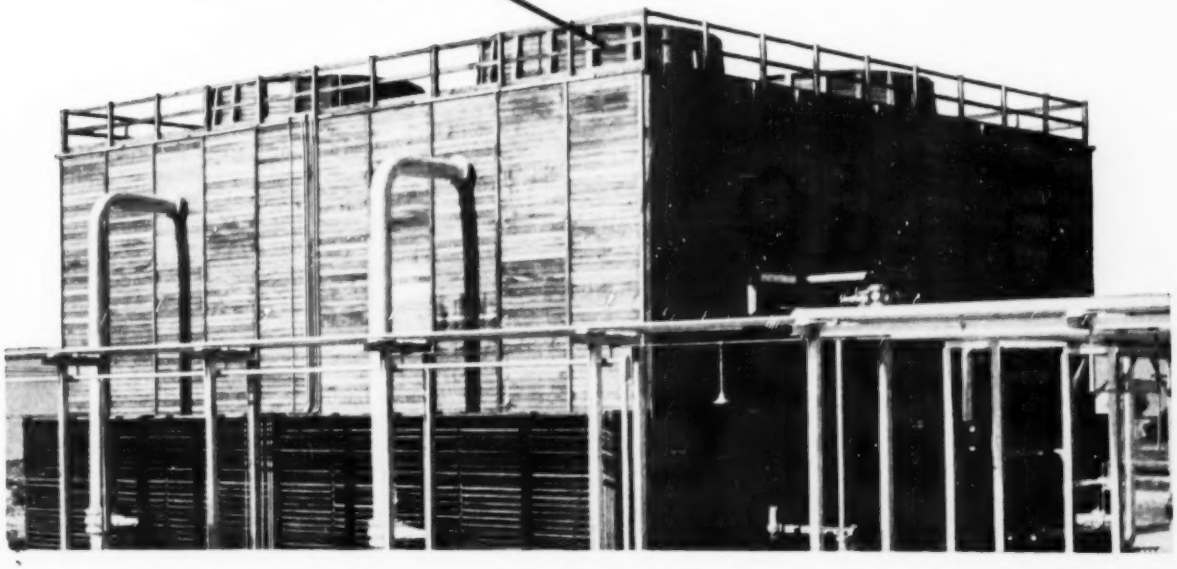

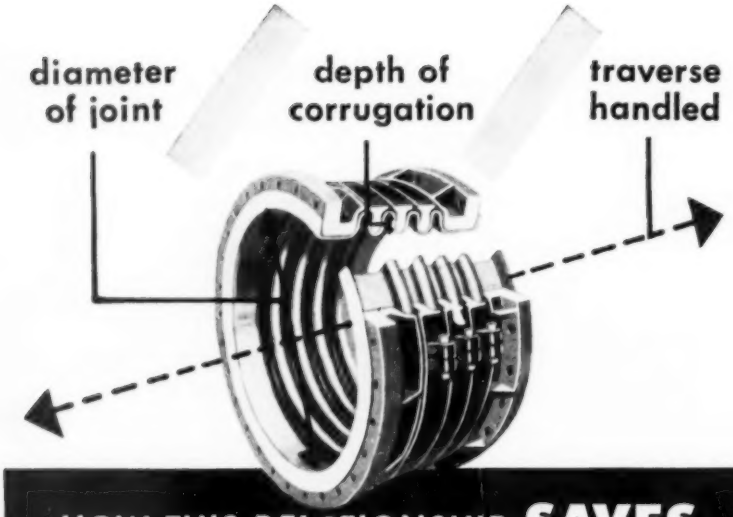


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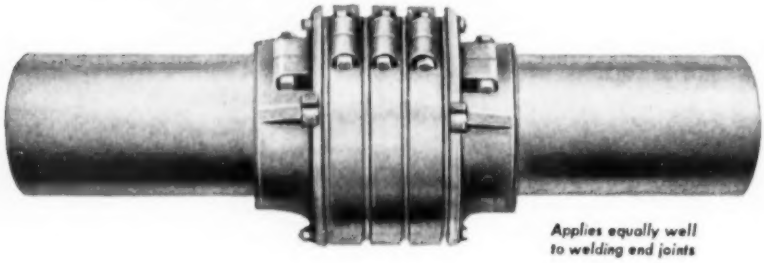

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## What's New!

### Ketones

. . . and their uses in industry; 46-page *Booklet F-4767* discusses the 14 types made in commercial quantities by the company, gives their specifications, shipping data and constant boiling mixtures, with a bibliography to important references in chemical literature. Carbide & Carbon Chemicals Co., 30 E. 42nd St., New York 17, N. Y.

*Circle No.* **41** *on Reply Card*

### Pressure Equipment

. . . including separators, traps and boiler trim with size and pressure tables and technical data; in 10-page *Catalog* 400, which is a condensation of the manufacturer's Catalogs 400, 500 and 600. Wright-Austin Co., 3245 Wight St., Detroit 7, Mich.

*Circle No.* **42** *on Reply Card*

### Worm Gear Sets

. . . and speed reducers of the double-enveloping type; 4-page *Bulletin FCP-53* shows how the equipment is used in refining and chemical processing plants. Cone-Drive Gears, Division Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.

*Circle No.* **43** *on Reply Card*

### Electronic Instruments

. . . included in over 20,000 items listed and priced in the 268-page manufacturer's 1954 Catalog, which details equipment ranging from voltage stabilizers to plant-wide address systems. Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.

*Circle No.* **44** *on Reply Card*

### Solids Contact Reactor

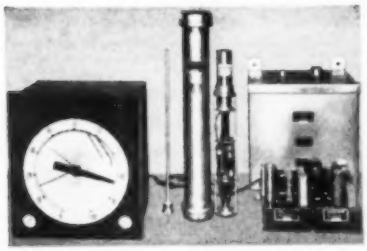
. . . for clarifying and/or lime softening of water; 24-page *Bulletin 5001-A* explains the principles of the solids contact principle, and shows the basic reactor types which can be supplied by the manufacturer. Cochrane Corp., Philadelphia, Pa.

*Circle No.* **45** *on Reply Card*

### Dial Thermometers

. . . for long distance measurement; an outline of the types of equipment which the company has available, which emphasizes variety of ranges, and bulbs, tubing and accessories obtainable; also includes complete data on temperature indicators of vapor pressure and gas pressure types; in 16-page *Bulletin* 467. Foxboro Co., Foxboro, Mass.

*Circle No.* **46** *on Reply Card*



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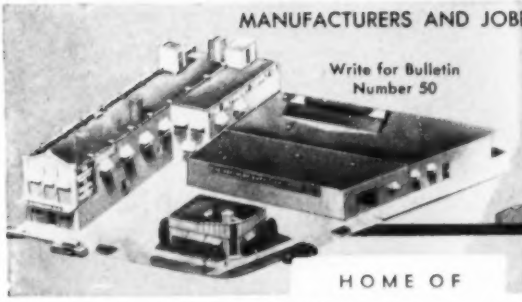

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## What's New!

### Synthetic Surfactants

. . . or Igepons, formed by chemical reaction of a fatty acid with an organic sulfonate; 18-page booklet discusses six types of Igepon in the manufacturer's products line, and outlines their uses in many industries, including petroleum and chemical processing. General Dyestuff Corp., 435 Hudson St., New York 14, N. Y.

*Circle No.* **47** *on Reply Card*

### Gross Heat Output

. . . for all types of boilers, tanks and heaters; information supplied in 24-page booklet to help in the proper sizing and selection of pressure relief valves; formulas and tables cover recommended valves for cast-iron and steel boilers, as well as those for which there is no nameplate data or set procedures for establishing output. McDonnell & Miller, Inc., 3500 N. Spaulding Ave., Chicago, Ill.

*Circle No.* **48** *on Reply Card*

### Process Control

. . . instruments of all kinds; described and priced in the manufacturer's 42-page *Catalog TC*10, which includes temperature conversion tables and thermocouple calibration data. Wheelco Instruments Division, Barber-Colman Co., Rockford, Ill.

*Circle No.* **49** *on Reply Card*

### Relief Valves

. . . for steam, air, gas, water, oil and other liquids; 12-page *Circular* 502 contains steam, air and gas relieving capacity tables and a table of multipliers for computing relieving capacities at various inlet temperatures. Lunkenheimer Co., Box 360, Cincinnati 14, Ohio.

*Circle No.* **50** *on Reply Card*

### Ceramic Bubble Caps

. . . for use in fractionation towers; a discussion of their advantages, of which the biggest seems to be resistance to corrosion; in 4-page bulletin. Keystone Tool Corp., 5325 Kirby Drive, Houston, Texas.

*Circle No.* **51** *on Reply Card*

### Pipe Pressure-Temperature

. . . ratings, more than 5,000 of them, on the various grades of pipe commonly used in power plants; in 28-page *Bulletin TB*1-1953. Pipe Fabrication Institute, 813 Clark Bldg., Pittsburgh 22, Pa.

*Circle No.* **52** *on Reply Card*

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### Cooling Tower Design

. . . and manufacturer's construction and operation principles; described and illustrated in 36-page booklet, which also outlines company's services on installation, servicing, etc. Fluor Corp., Los Angeles 22, Calif.

*Circle No.* **53** *on Reply Card*

### Refinery Construction

. . . at Cardon, Venezuela, by the Lummus Co.; a profusely illustrated description of how the company put up a 170,000 b/d plant under trying circumstances; in 24-page booklet. The Lummus Co., 385 Madison Ave., New York 17, N. Y.

*Circle No.* **54** *on Reply Card*

### Spectro Calculator

. . . of fan scale design, said to eliminate the need for actually plotting emulsion characteristic curves; 4-page bulletin describes the operation of this new instrument and gives structural information on the board. Jarrell-Ash Co., 26 Farwell St., Newtonville, Mass.

*Circle No.* **55** *on Reply Card*


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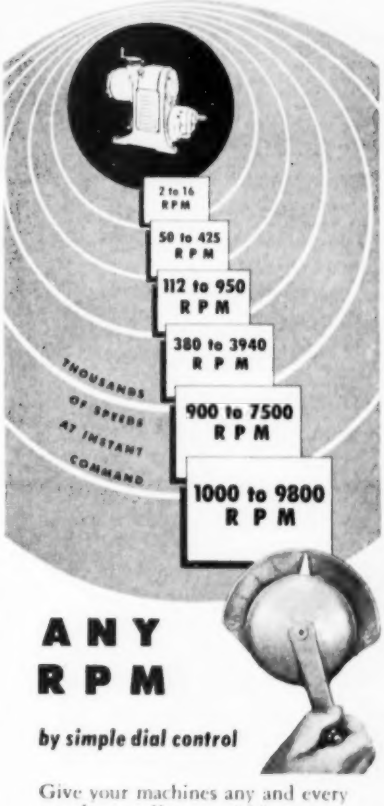


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| Min. 98.5% powder | IRON CONTENT: Max. 0.01% |

2. TECHNICAL GRADE (SUBLIMED):

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## What's New!

### Laboratory Services

. . . and consultation on how the manufacturer's chemical additives, industrial chemicals, etc., can be used in many phases of industry, including protective coating, gasoline and chemical operations; in 20-page brochure. Eastman Chemical Products, Inc., Kingsport, Tenn.

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### Testing Instruments

. . . such as hook-on volt-ammeters, hook-on wattmeters, portable recorders, voltmeters, ammeters, etc.; a buyer's guide to the manufacturer's products, with application data, features of each instrument, and prices; in 16-page *Bulletin GEA*-5469B. General Electric, Schenectady 5, N.Y.

*Circle No.* **57** *on Reply Card*

## Did You Miss These?

*The following items, reviewed originally in September, have aroused considerable interest among the readers. They are repeated briefly as a service to those who might have missed them the first time. For details or literature, use the regular Reply Card in this issue.*

### Safety Relief Valve Design Uses Internal Heat Exchanger

. . . eliminating the need for steam tracing or jacketing where highly viscous lading might be encountered. The unit consists of a steel coil inserted into the valve body and led out to connect with a steam line. Coil ends are accessible for return pipe installation, or one-pipe installation with a vent valve. A steam trap drains the coils. Construction is suitable for back pressure use. The device is available for installation in all of the maker's nozzle and semi-nozzle valves. Farris Engrg. Corp., 533 Commercial Ave., Palisades Park, N. J.

*Circle No.* **58** *on Reply Card*

### New Spray Type Insulation for Metal Withstands up to 5000° F.

. . . and will adhere directly to clean surfaces without sandblasting or use of primer preparations. Called "Pyrolock," a 1/16-in. coating protects metal for as long as ten seconds against flame temperatures hotter than the

melting points of metals. Described by the manufacturer as a water base inorganic material, it was developed originally at the request of the Defense Dept. for use in the rocket and guided missile field. A dried layer of Pyrolock bonds with a strength that withstands sharp impacts short of actual deformation of the base metal. Resistant to most solvents and chemicals, the material also can withstand indefinite temperature cycling from —60 to 165° F. B. F. Goodrich Co., Industrial Products Division, Akron, Ohio.

*Circle No.* **59** *on Reply Card*

### Spectrophotometry

. . . and what today's executives should know about it; a 14-page *Bulletin* 295-23 explaining in layman's language what spectrophotometry is, what its uses are, and how it works. Beckman Instruments, Inc., So. Pasadena 1, Calif.

*Circle No.* **60** *on Reply Card*

### Guide to Anhydrous Ammonia

. . . use in cylinders; description of physical, chemical properties, specifications, applications, handling techniques, and safety precautions; in 20-page manual. Allied Chemical & Dye Corp., 40 Rector St., New York 6, N. Y.

*Circle No.* **61** *on Reply Card*

### Ethylene Amines

. . . physical, chemical, and physiological properties; specifications and shipping data; described in 4-page *Technical Bulletin* F-8163. Carbide and Carbon Chemicals Co., 30 East 42nd St., New York 17, N. Y.

*Circle No.* **62** *on Reply Card*

**For Your Convenience**

Business reply cards are included in each issue of Petroleum Processing to assist you in obtaining more information on any items reviewed in "What's New!" You'll find them facing the first page of this section. Just circle the numbers corresponding to the numbers at the end of each item. Then fill in the rest of the card and drop it in the mail. No postage is required.


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**BULLETIN AD607:** *Contains helpful charts and data on most efficient methods of controlling various combustion processes.*

**BULLETIN AD608:** *Outlines savings to be made with oxygen control in Cat Cracking operations, gives sampling suggestions and list of equipment.*

**BULLETIN AD612:** *Describes gas monitoring system for gas plants and compressor stations, shows sampling arrangement, lists equipment required.*

**BULLETIN AD701:** *Describes a sampling system particularly suited for Cat Cracker applications . . . includes illustration of equipment layout.*

*The above informative literature will gladly be sent you free. For maximum convenience, use the coupon at right.*

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# EDITORIALS . . .

## This Job Calls For Organizing

FOR the first time in 25 years petroleum refiners will have survey data on the costs resulting from the corrosion of metal in their equipment, vessels, tanks, pipelines and so on. Some figures are already at hand, derived from a study made by the PETROLEUM PROCESSING Editorial Staff and reported in this issue (pg. 1685). More accurate data is expected to be available shortly from a cost survey being carried on by a group of refinery engineers and metallurgists under the supervision of the API Refining Division's Committee on Refinery Equipment.

There may be considerable discrepancy in the two sets of data, for many different factors enter into even the direct costs which arise from the wastage of metals in plants and their equipment. Whatever the differences may amount to, the figures still will show that the total additional operating and maintenance costs with which refiners are burdened from this cause reach startling figures.

One technologist has appraised the problem by stating that there is no other potential saving to refiners in common as great as that possible from reducing their losses from metal corrosion.

In view of the costs involved it is hard to understand the lethargy of some refining companies today in failing to attack more vigorously the corrosion losses in their plants. The principal reason has likely been that there has been available no actual knowledge of what the costs might be for the individual company or for the industry as a whole.

By way of comparison, refiners in this country have been well organized since the early '30's in fire protection and accident prevention work both within their plants and industry-wide. The companies work cooperatively through the API and through such outside organizations as the National Fire Protection Assn. and the National Safety Council. No dollar value can be assigned to the accident prevention work but the companies' well organized work in this field has achieved a fine low accident rate for the industry. The refining industry's reported fire losses total only a few million dollars a year, a very small proportion of the minimum estimates put forward for even direct corrosion losses.

Material advances are being made in the techniques of corrosion protection and in handling metal wastage problems of various types. Progress is also being achieved in the more basic studies leading to the prevention of corrosion, thereby reducing the actual wastage in the plants. More attention from management is needed to see that their plants are adequately staffed with the skill and experience for corrosion protection work, and that the work of the individual oil companies is correlated. By this means the oil companies can best take advantage of the developments being made in corrosion engineering to reduce the corrosion losses in their own plants.

The API Refining Division's Corrosion Committee for some time has been making a study of various phases of the oil companies' corrosion problems, in addition to its cost studies. Their report, when made, should recommend a program for the industry to follow, to the end of reducing the present heavy costs. Their recommendations should have the complete backing and support of the oil company top executives. Such support is necessary if we are to make real headway in reducing this present largest factor in refinery maintenance costs.

—V.B.G.

## The Most Startling Developments . .

THE most startling developments in chemistry in the next few years will be in the organic field, based largely on petroleum derivatives and natural gas."

This prediction was made by Hugo Riemer, president of an old-line chemical company—Nitrogen Division of Allied Chemical & Dye Corp.—at the formal opening of a new organic development center for the firm at Hopewell, Va., recently. They indicate a growing recognition of the tremendous importance of the petrochemical industry today and tomorrow.

"Although the older, inorganic branch of the chemical industry will continue to expand, the rapidly growing field of organic chemistry promises to become equally as large," Mr. Riemer said.

"Organic chemistry . . . has been responsible for a large part of the industry's recent expansion. The purpose of this (Hopewell) development center is to expand our participation in the organic field, at the same time continuing our nitrogen research on a broad basis.

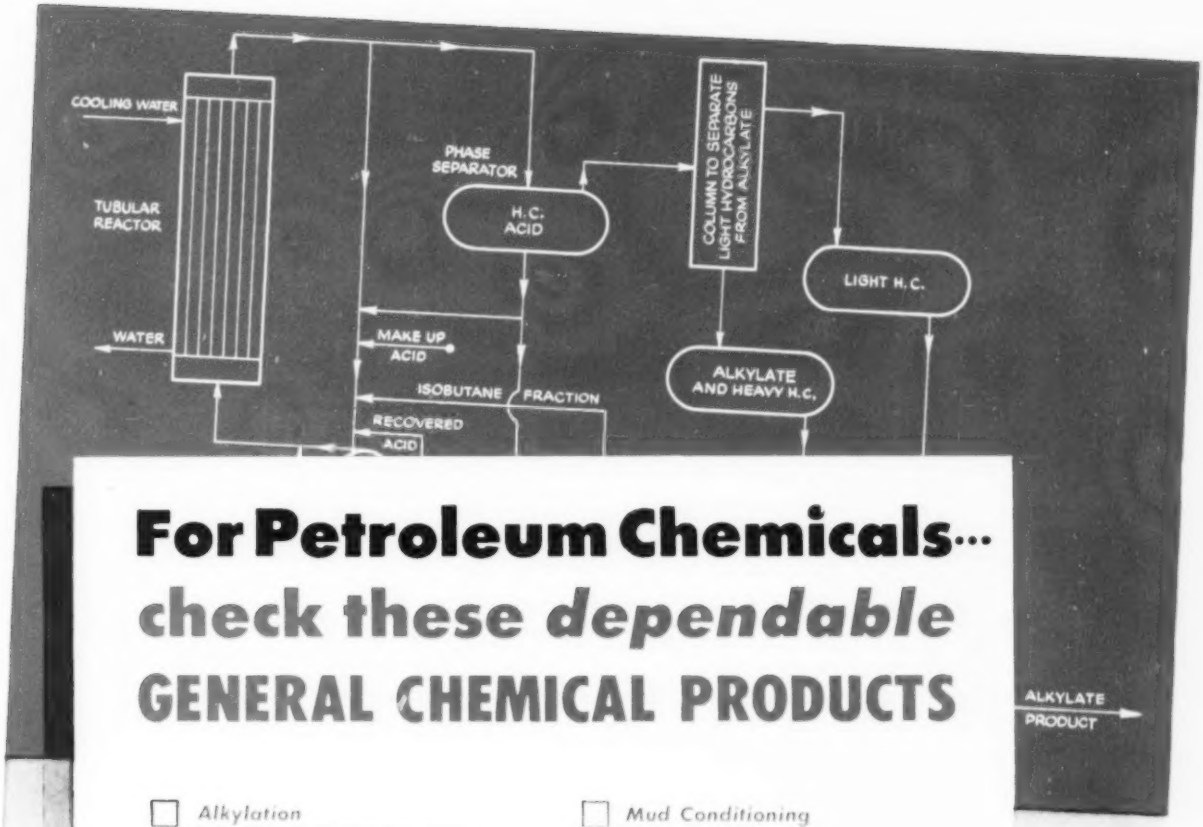
" . . . Today our research men in this new laboratory face the challenge to explore the vast field of organic chemistry from petroleum and natural gas for new products potentially as valuable to mankind as our nitrogen developments."

Exemplary of the kind of thing Mr. Riemer meant is the current initial project of the Nitrogen Division in the organics field—a plant now under construction at Orange, Texas, and scheduled for completion early next year. It will produce ethylene oxide, ethylene glycol, and other ethylene derivatives used in so many different industrial and consumer goods, including anti-freezes, synthetic fibers, detergents, plastics, lubricants, solvents, and explosives. In addition, other products are being developed for use as intermediates in manufacturing processes.

## Tribute to Technology

FIGURES have been published by Esso Standard Oil Co. for the volume of feed stock processed by a Fluid catalytic cracking unit installed in its Baton Rouge refinery in the summer of 1943. Originally designed for 15,000 bbls. capacity, in the past year the unit processed 19,336,700 bbls. of charge, a daily average of 53,000 bbls. Highest feed rate for one day was 68,300 bbls. The unit was one of the earlier models of the Fluid units, of which 31 were installed during the war. Expansion and bottleneck removal, another term for technology in the field, brought about the achievement.

—V.B.G.

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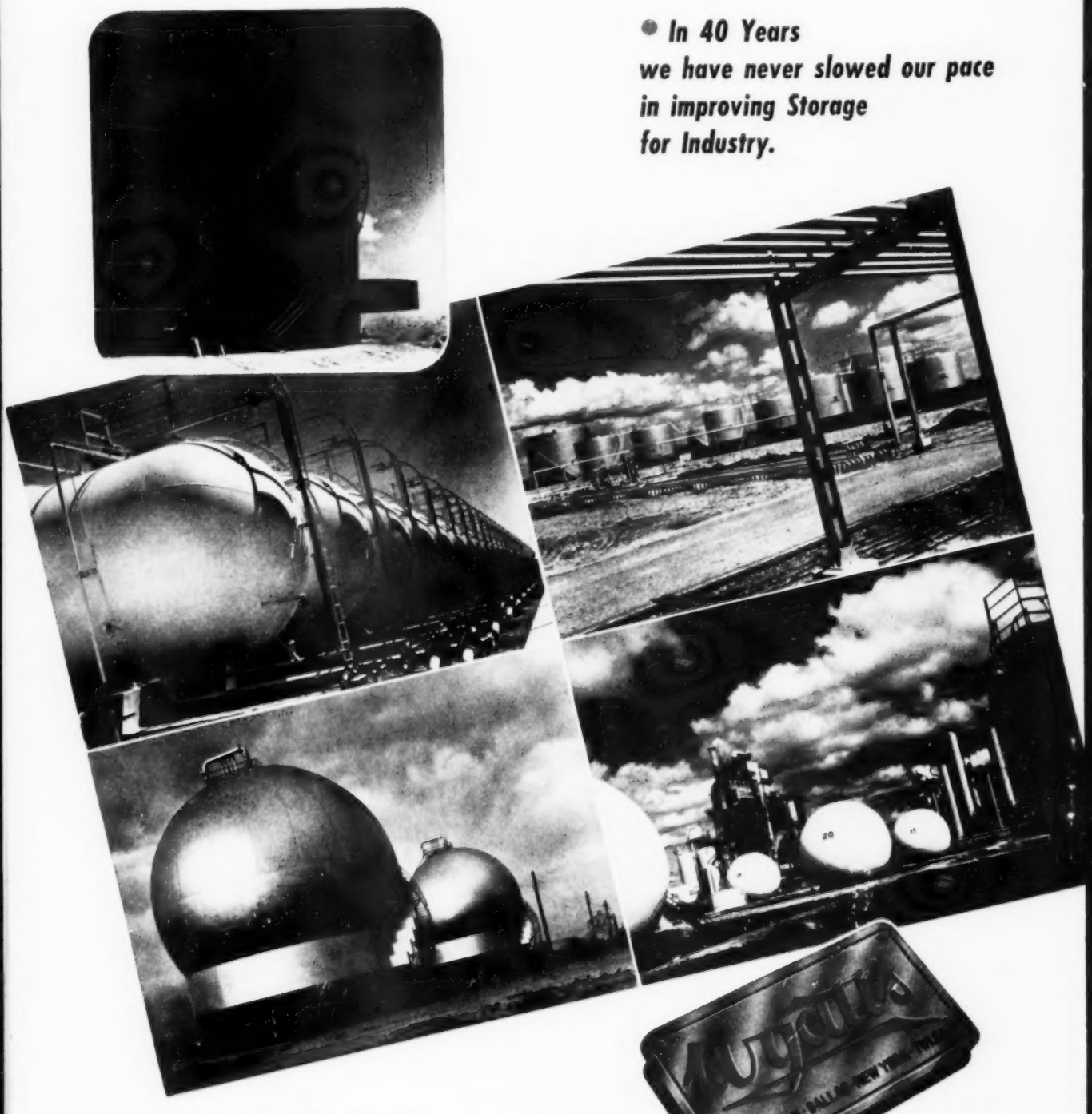

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